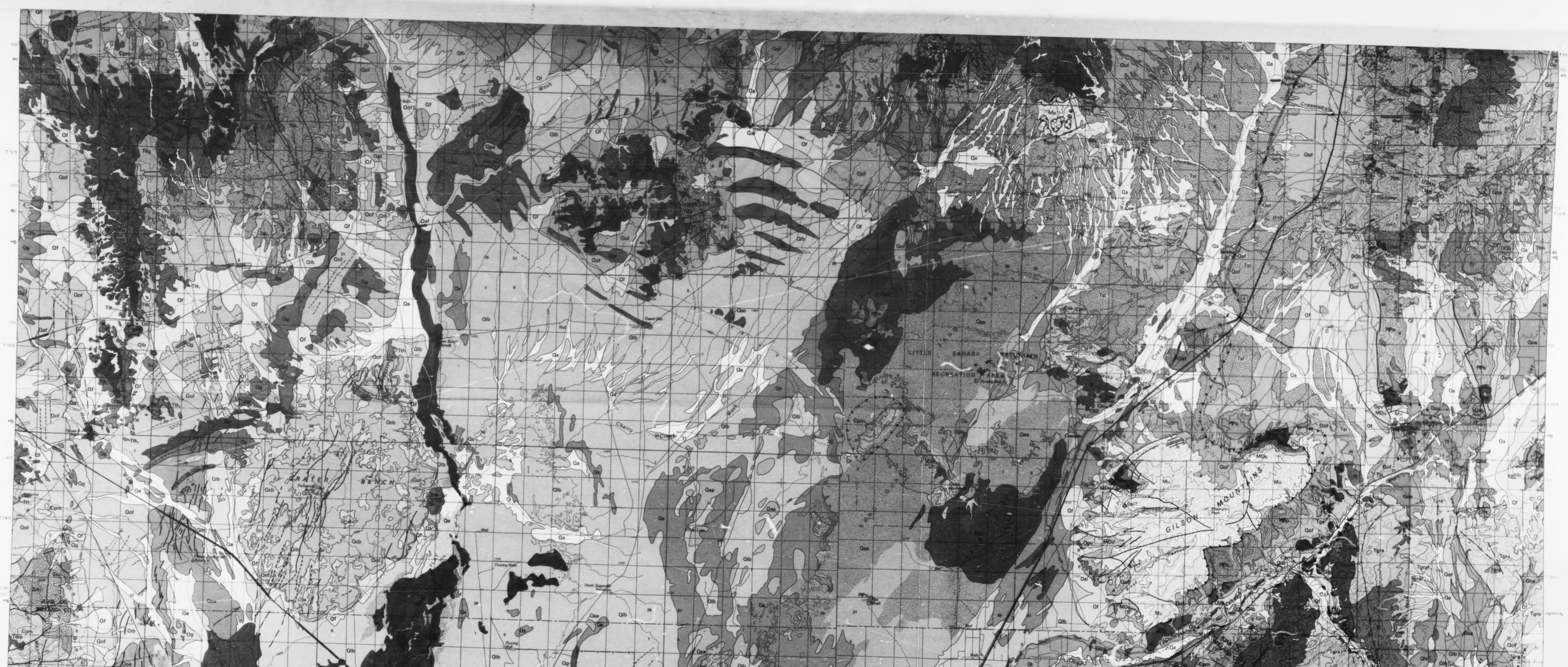


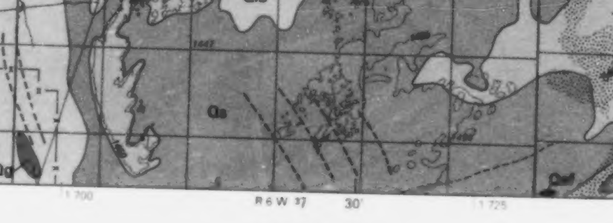
Base from U.S. Geological Survey, 1975

INDEX TO 1:24 000-SCALE MAPS

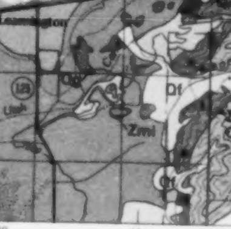
1	2	3	4	5	6	7	8
9	10	11	12	13	14	15	16
17	18	19	20	21	22	23	24
25	26	27	28	29	30	31	32

1	Table Mountain 1955
2	Coyote Springs 1955
3	Indian Springs 1955
4	Erickson Knoll 1971
5	Dutch Peak 1963
6	Sabie Mountain 1963
7	Tintic Junction 1954-75
8	Eureka 1954-75
9	Keg Pass 1971
10	Keg Mountain Ranch 1971
11	Erickson Wash SW 1971
12	Desert Mountain Pass 1971
13	Cherry Creek 1963
14	Maple Peak 1963
15	McIntyre 1954
16	Tintic Mountain 1954-75
17	Picture Rock Hills 1971
18	The Hogback 1971
19	Crater Bench Reservoir 1971
20	Desert Mountain Reservoir 1971
21	Mammoth 3 NW prelim. 1962
22	Mammoth 3 NE prelim. 1962
23	Jericho 1967
24	Furner Ridge 1967
25	Drum Mountains Well 1971
26	Fumarole Butte 1971
27	Baker Hot Springs 1971
28	Rain Lake 1971
29	Mammoth 3 SW prelim. 1962
30	Mammoth 3 SE prelim. 1962
31	Champlin Peak 1967
32	Sage Valley 1967

SCALE 1:100 000



CONTOUR INTERVAL 50 METERS



QUADRANGLE LOCATION

GEOLOGIC MAP OF THE LYNNDYL 30- BY 60-MINUTE QUADRANGLE, WEST-CENTRAL UTAH

By

Earl H. Pampeyan

1989

DESCRIPTION OF MAP UNITS

Qa ALLUVIUM (HOLOCENE)—Stream, river, and channel deposits consisting of clay- to cobble-size, poorly sorted, crudely stratified, and generally undissected detrital material. Commonly less than a few meters thick but locally may reach 10 m. Locally may include alluvial fan deposits (Qf) and stream terrace deposits (Qt). Overlies Lake Bonneville shoreline features

Qf ALLUVIAL FAN DEPOSITS (HOLOCENE)—Unconsolidated, poorly sorted alluvial fan deposits of sand and gravel, largely derived from older alluvial (Qoa) and older fan deposits (Qof). Deposits are crudely stratified, subhorizontal to moderately dipping. Thickness is usually less than 5 m. Commonly overlie the older alluvial deposits. Locally may include alluvium (Qa) and older fan deposits (Qof). Generally undissected and smaller in areal extent and volume than older fan deposits

Qs EOLIAN SAND, UNDIVIDED (HOLOCENE)—Windblown loose to weakly consolidated, coarse- to fine-grained quartz sand and silt with some clay forming flat-lying and cross-bedded deposits, active dunes, and old stabilized dunes derived principally from Lake Bonneville deposits to the south-southwest. Largely divided into

Qsa Active dunes—Loose sands in south-central part of map area, part of which is designated Little Sahara National Recreational Area. In places active dunes overtop bedrock ridges whose exposure varies with the amount of wind action, for example, the Sand Hills. Thickness unknown but in places the dunes are more than 20 m high

Qso Old dunes—Weakly consolidated sand in dunes which appear to be stabilized, at least in part, by a light cover of vegetation. Thickness unknown but in places the old dunes are exposed over a vertical distance of more than 60 m

Qp PLAYA DEPOSITS (HOLOCENE)—Unconsolidated flat-lying deposits of silt and moderately expansive clay derived mostly from Lake Bonneville sediments that accumulated in closed basins in or near the Old River Bed. Thickness unknown but probably does not exceed a few meters

Qls LANDSLIDE DEPOSITS (HOLOCENE)—Irregular bodies of rock and soil that have moved downward and outward from an adjacent source area. Many more exist than are shown. Some may be pre-Holocene in age

Qaf ARTIFICIAL FILL (HOLOCENE)—Man-made debris, slag heaps, mine dumps, mill tailings, and earthworks constructed from local materials. Some, such as embankments for dams, highway and railroad roadbeds, and engineering structures are engineered fills, others are random accumulations of various materials. Although not shown as the artificial fill unit, much of the Intermountain Power Project site is covered with graded and compacted local and imported earth materials

Qt STREAM TERRACE DEPOSITS (HOLOCENE)—Unconsolidated, poorly sorted alluvial deposits of silt, sand, and gravel forming a crudely layered nearly flat-lying veneer on older geologic units adjacent to modern drainage channels. Mapped only along the Sevier River near Leamington where they may be as much as 10 m thick

Qh HOT SPRING DEPOSITS (HOLOCENE AND PLEISTOCENE?)—Chiefly light-gray clay, silt, and sand and reddish-brown manganese-rich calcareous tufa in a spring mound. Mound has built up around hot springs in part by precipitation of minerals from spring water but largely by entrapment of eolian sediment by vegetation and wet ground. Exposed thickness is less than 5 m. Mapped only at Baker Hot Springs on east side of Crater Bench

Qlb DEPOSITS OF LAKE BONNEVILLE (PLEISTOCENE)—Lake sediments which consist of interlayered white, light-gray, brown, tan, and yellowish-gray clay, silt, sand, marl, and gravel. The clay, silt, and sand range from light-gray, yellowish-gray and tan to brown depending on exposure to dessication and weathering, the light colors prevailing in natural outcrops; the fine clastic sediments commonly occur as alternating layers. Well-exposed near Leamington where thickness exceeds 80 m. Marl, widely exposed in southwest quarter of map area, is yellowish-gray to white and composed almost entirely of minute ostracod shells; most of the marl is laminated and massive but some is fissile. In several places the marl is underlain by rusty-colored gravel, possibly representing one or more old soil horizons. Maximum thickness of exposed marl is 5 m on east side of Drum Mountains. Locally the land surface is strewn with ooliths formed of gastropod shells coated with calcium carbonate. Black basaltic ash is present in marl near Leamington (Varnes and Van Horn, 1961; 1984), and rhyolitic ash is present in lake beds west of Lynndyl (Krusi and Patterson, 1980); radiocarbon age dates from shells adjacent to basaltic ash horizons range from about 11,000 to more than 32,000 y.B.P.; dates from shells west of Lynndyl range from about 11,600 to 12,700 y.B.P. The rhyolitic ash correlates with the Bishop Tuff (700,000 y.B.P.) and fission-track dates from zircons in the ash give an age of 730,000 ± 73,000 y.B.P. (Krusi and Patterson, 1980)

Qg GRAVEL AND SAND DEPOSITS (PLEISTOCENE)—Spits, bay-mouth bars, tombolos, cuspate forelands and bars, and crescent beaches present at or below the Bonneville shoreline, which ranges in elevation from 1559 to 1593 m (Currey, 1982) across this quadrangle; features are especially well developed in west half of map area. Consist largely of reworked old alluvial fan deposits and contain moderately well-sorted sand- to cobble-size rounded clasts. Mostly lacustrine bar deposits but includes some fluviatile stream terrace gravels interbedded in lake sediments along the Old River Bed and along the Sevier River between Leamington and Lynndyl (Varnes and Van Horn, 1961, 1984). Includes The Snowplow (southwest corner of Simpson Mountains), Reservation Butte and Cup Butte (see fig. 6) of Gilbert (1890)) and numerous other well-defined and well-preserved coarse shoreline deposits in the Slow Elk Hills, west slope of the Simpson Mountains, Keg Mountain and adjacent to Desert Mountain, and the wave-bench deposits of Galyardt and Rush (1981) on The Hogback of Crater Bench. Locally the gravels are cemented with calcareous tufa. The gravel and sand deposits range in thickness from a few meters in beach deposits to several tens of meters in [illegible], cuspate forelands, and bars

Qoa OLDER ALLUVIUM (PLEISTOCENE)—Stream, river-channel, and basin deposits consisting of clay- to small boulder-size detrital material. Poorly sorted, crudely stratified, and moderately to deeply dissected. Thickness ranges from a few to tens of meters. Locally includes old stream terrace deposits

Qof OLDER FAN DEPOSITS (PLEISTOCENE)—Semi-consolidated, poorly sorted alluvial deposits of sand and gravel forming large fans bordering upland areas. Deposits, several tens of meters thick, are crudely stratified parallel to the sloping fan surface, and commonly are deeply dissected. Older fan deposits lower than the Bonneville shoreline in many places were reworked by wave action and marked by strand lines. Locally include coarse- and fine-grained deposits of Lake Bonneville, pediment gravels, colluvium and older alluvium (Qoa). Include talus deposits in the Sheeprock Mountains and wave-worked talus deposits surrounding Crater Bench. In northeast corner of map area include loess, alluvium and colluvium, pre-Wisconsin (glaciation) soil, and landslides (Goode, 1961), and east of Eureka include old stream terrace gravels (Morris and Lovering, 1979)

Tsl SALT LAKE FORMATION (PLIOCENE AND MIOCENE)—Predominantly reddish-brown to grayish-orange, semi-consolidated, siltstone and calcareous clay, with lesser amounts of green and red tuffaceous bentonitic clay, light-gray to white marly limestone, and thin pebble to cobble gravel lenses. Includes a poorly exposed section of reddish-brown to pink sandy silt and clay more than 30 m thick unconformably overlain by Quaternary basalt at the south edge of Crater Bench. Includes some tuffaceous deposits thought to correlate with the Huckleberry Ridge ash bed dated at 2.20 m.y. (H.T. Morris, oral commun., 1983; Izett and Wilcox, 1982). Thickness exceeds 600 m (Morris and Kopf, 1970b)

FLAGSTAFF LIMESTONE (EOCENE AND PALEOCENE)—Cream-colored silty, sandy, and algal limestones, shale, sandstone, and pebble conglomerate present only in extreme southeast corner of map area where a tongue of red, well-cemented cobble conglomerate is interlayered with the limestone. Section exposed is 60 m thick

CANYON RANGE FORMATION OF STOLLE (1978) (PALEOCENE AND (OR) UPPER CRETACEOUS)—Synorogenic poorly sorted, red-weathering, weakly cemented, pebble to cobble conglomerate with brick-red sandstone and shale interbeds overlain by an interbedded sequence of yellowish-orange to purplish-gray coarse to fine clastic and limestone strata. Correlated with the Flagstaff, North Horn, and Price River Formations farther east. Present along east side of the Canyon Mountains. Originally mapped by Christiansen (1952) as the Upper Cretaceous Indianola(?) Group. Called the Upper Cretaceous and Paleocene North Horn Formation, Price River Formation and Indianola Group undivided by Campbell (1979), and mapped by Higgins (1982) as the Cretaceous and Tertiary Conglomerate of Leamington Pass. Locally contains large slide blocks of limestone. About 1,050 m thick

TKn NORTH HORN FORMATION (PALEOCENE AND UPPER CRETACEOUS)—Brick-red conglomerate, sandstone, siltstone and some silty and sandy limestone. Present only in extreme southeast corner of map

EXTRUSIVE AND SEDIMENTARY ROCKS

Qcb BASALT OF CRATER BENCH (PLEISTOCENE)—Black, fine-grained flows of basaltic andesite, grading from vesicular to non-vesicular upwards from base of flow units. Same as Fumarole Butte flows of Hogg (1972) and basalts of Crater Bench of Galyardt and Rush (1981). Overlies lacustrine deposits of the Salt Lake Formation; overlain by Lake Bonneville deposits. K-Ar age determined as 0.88 m.y. (Peterson and Nash, 1980) and 0.95 ± 0.1 m.y. (Galyardt and Rush, 1981). Maximum thickness estimated to be about 180 m near Fumarole Butte thinning to a few meters or less at the margins

Qcc CINDER CONE DEPOSITS (PLEISTOCENE)—Remnant of cinder cone around a vent, presumed source of the basalt of Crater Bench (Qcb). Consist of densely welded cinders intruded by fine-grained dense basalt and surrounded by non-welded cinders. Locally as much as 50 m thick

Th BASALT OF THE HOGBACK (MIOCENE)—Black vesicular tholeiitic basalt flows as much as 45 m thick that form The Hogback of Crater Bench. Equivalent to the North Butte flow of Hogg (1972), and the basalt of the Hogback of Galyardt and Rush (1981). K-Ar age 5.26 ± 0.42 m.y. (Galyardt and Rush, 1981) and 6.03 m.y. (Peterson and Nash, 1980). Included in the Quaternary basalt flows unit by Morris (1978). Age is late Miocene

Tc CONGLOMERATE (MIOCENE)—Reddish-brown conglomerate and interlayered sandstone containing sand- to boulder-size clasts of white to pink quartzite and lesser amounts of dark-gray limestone, and pumice, rhyolite, and basalt. The conglomerate locally is cemented with calcium carbonate and resistant to erosion. Thickness of exposed section exceeds 229 m. A thin tuff bed is present near base of section and clasts of the Topaz Mountain Rhyolite are present near top of section. Mapped only at north end of Crater Bench as Tertiary conglomerate by Hogg (1972), Peterson and Nash (1980), and Galyardt and Rush (1981). Age is late Miocene

TOPAZ MOUNTAIN RHYOLITE (MIOCENE)—Chiefly light-gray alkali rhyolite flows with some black vitrophyre at base of flow units and some white to tan interbedded stratified tuff. Four fission-track and two K-Ar dates of flows in the type area range from 6.1 ± 0.4 to 6.8 ± 0.3 m.y. (Lindsey, 1979). Included in the younger acidic volcanic rocks unit by Morris (1978). Age is late Miocene. On this map divided into the rhyolite of The Hogback and the rhyolite flows, plugs, and dikes of Keg Mountain:

Rhyolite of The Hogback—Light-gray flow-banded rhyolite with some black vitrophyre, both of which contain phenocrysts of sanidine up to 4 mm long and quartz. Lithophysae as large as 2 cm in diameter in the rhyolite are filled with drusy quartz crystals. Weathers to a coarse irregular vuggy surface. Exposed under basalt flows (Th) at north tip of Crater Bench. Thickness exceeds 40 m. Equivalent to the rhyolite of The Hogback of Galyardt and Rush (1981). K-Ar dates are 6.87 ± 0.28 m.y. (Mehnert and others, 1978) and 6.18 m.y. (Peterson and Nash, 1980)

Rhyolite flows, plugs, and dikes of Keg Mountain—Light-gray to reddish-gray flows, plugs, and dikes of aphanitic to porphyritic rhyolite; some units have chilled margins of obsidian and spherulitic rhyolite, and locally include lithophysal zones, minor flow breccia, tan to white compact friable tuff locally silicified or welded, and gray quartz latite porphyry containing numerous phenocrysts of quartz, sanidine, and plagioclase. Total thickness unknown but thought to exceed a few hundred meters. These volcanic rocks extend eastward from the type area in the Thomas Range (Lindsey, 1979) and also contain accessory topaz, hematite, bixbyite, and pseudobrookite but in lesser amounts than in the type area (Staub, 1975). Subscripts indicate two successive flow units, Tkt_1 being the older, commonly separated by tuff and (or) vitrophyre from the younger Ttk_2 flow. Includes the Keg Mountain rhyolite unit, porphyritic rhyolite of West Mountain unit, Keg Mountain tuff unit, and Drum Mountain rhyolite unit of Staub (1975) and the rhyolite of Keg Mountain of Shawe (1972) and Lindsey and others (1975) in Keg Mountain, and rhyolite flows of Dommer (1980) in the Drum Mountains. Two fission track dates of flows in Keg Mountain indicate an age of about 8 m.y. (Lindsey, 1979; Lindsey and others, 1975)

EXTRUSIVE BRECCIA (MIOCENE)—Material erupted from breccia pipes (Tib) during early explosive stage consisting of small fragments to large blocks of Precambrian to Tertiary sedimentary and igneous rocks in a matrix of tuffaceous breccia containing shattered crystals of quartz, feldspar, and biotite. Widely exposed in the southern Sheeprock Mountains (Morris and Kopf, 1970b; Morris, 1978) where it may be in excess of 90 m thick; mapped as rhyolite porphyry by Kattleman (1968) and as the diatreme(?) complex by Rees and others (1973) in Desert Mountain where it is exposed over a vertical distance of more than 200 m

Tss SILVER SHIELD QUARTZ LATITE (MIOCENE)—Medium- to dark-gray coarsely porphyritic flows and dikes in northeast corner of map area. Phenocyrsts of plagioclase, quartz, biotite and augite up to 15 mm long are set in a very fine grained to aphanitic matrix with a high proportion of K-feldspar and quartz. The Silver Shield has a maximum thickness of 38 m (Morris and Lovering, 1979). Age is considered middle Miocene based on K-Ar dates ranging from 17.9 ± 0.5 to 18.3 ± 0.5 m.y. (Laughlin and others, 1969). Included in the younger intermediate volcanic rocks unit by Morris (1978)

Tpc PINYON CREEK CONGLOMERATE (MIOCENE)—Grayish-tan to reddish-brown conglomerate composed of sub-angular to rounded, pebble- to boulder-size monolithologic volcanic clasts interlayered with silt- to grit-size volcanic debris. Conspicuously bedded; lensing and channeling are common. Individual beds may be poorly- or well-sorted. The Pinyon Creek Conglomerate is mapped only in the northeast corner of map, where it is more than 300 m thick. Included, along with Miocene conglomerate (Tc) at The Hogback, in the Miocene gravel unit by Morris (1978). Age is early Miocene

JASPEROID (OLIOGCENE?)—Silicified and opalized Tertiary volcanic and Paleozoic carbonate rocks whose origin is apparently related to Oligocene volcanic activity. Includes silicified breccia on southeast side of Gilson Mountains on or near trace of Leamington transcurrent fault

JUDD CREEK LATITE (OLIGOCENE)—Gray to reddish-brown latite porphyry with phenocrysts of glassy to chalk-white andesine, up to 5 mm long, some quartz, and scarce biotite in a microcrystalline to aphanitic groundmass; the texture is progressively finer grained away from center of outcrop area. Thickness unkown but estimated to be greater than 60 m. Present in the eastern Simpson Mountains, where named the Judd Creek Latite by Thomas (1958), and in the western Sheeprock Mountains; on this map includes several small isolated volcanic outcrops on west side of Simpson Mountains mapped as pitchstone and trachyte by Gilbert (1890). Paleozoic carbonate rocks are silicified locally along contact with overlying latite flows

UNALTERED EXTRUSIVE ROCKS OF DESERT MOUNTAIN (OLIGOCENE)—Pink to light-greenish-gray rhyolite to quartz latite porphyry with phenocrysts of quartz and K-feldspar in an aphanitic groundmass. Thickness unknown but probably exceeds 140 m. Equivalent to part of Kattelman's (1968) rhyolite porphyry unit, rhyolitic and quartz-latitic welded ash-flow tuff units of Shawe (1972), and unaltered pyroclastic volcanic rocks unit of Rees and others (1973) in east half of Desert Mountain. Includes small patches of the dark-purple to black quartz latite (dellenite) porphyry unit of Kattelman (1968) in southeastern part of Desert Mountain

LATITE AND QUARTZ LATITE EXTRUSIVE ROCKS OF WEST TINTIC MOUNTAINS (OLIGOCENE)—Chiefly purplish- to brownish-gray, medium-grained porphyritic lava containing phenocrysts of andesine, sanidine, biotite, augite, hornblende, and quartz in a fine-grained to microcrystalline groundmass probably containing much K-feldspar; locally underlain by a white, fine-grained tuff containing shattered crystals of andesine, sanidine, biotite, hornblende, and some quartz (Morris and Kopf, 1970a, 1970b). In places the tuff is argillized and silicified. Present in West Tintic and southern Sheeprock Mountains; total thickness probably exceeds 300 m. In adjacent areas the tuff unit is underlain by regolithic conglomerate (Ts). In western West Tintic Mountains map unit includes some thin tabular intrusive bodies of dark gray to black, fine grained olivine basalt

Tls LAGUNA SPRINGS VOLCANIC GROUP (OLIGOCENE)—Consists of the Tintic Delmar Latite, Pinyon Queen Latite, and North Standard Latite in the East Tintic Mountains (Morris and Lovering, 1979), all of which have similar chemical and mineralogical compositions and all contain hornblende which distinguishes them from rocks of the underlying Tintic Mountain Volcanic Group (Ttm). These are the extrusive equivalents of the monzonite porphyry of the Silver City stock (Tsc). The Tintic Delmar Latite consists of an upper flow member and a lower tuff member with a combined thickness of 0-122 m. The flow member is medium gray to dark reddish-brown, massive, medium-grained latite porphyry, characterized by large glassy to chalk-white phenocyrsts of feldspar, shiny black biotite crystals, and rare phenocrysts of hornblende and augite; the tuff member is a buff to white fine- to coarse-grained heterogeneous assemblage of volcanic ash, lapilli tuff, and agglomerate containing up to boulder-sized clasts. The Pinyon Queen Latite consists of an upper flow member and lower tuff member, both of which are virtually indistinguishable from their counterparts in the Tintic Delmar Latite, with a combined thickness of 0-335 m. The flow member is medium- to purplish-gray, massive, medium-grained latite porphyry; the tuff member consists of intermixed fine-grained boulder tuff and agglomerate. The North Standard Latite consists of an upper flow member and a lower tuff member with a combined thickness of 0-180 m. The flow member is dull purplish-gray to brownish-gray, massive fine- to medium-grained porphyry, the freshest outcrops of which show fragments of vitrophyre in a matrix of lighter-colored vitrophyre speckled with glassy to chalk-white phenocrysts of plagioclase and lustrous crystals of biotite; the tuff member is a gray to white heterogeneous agglomerate containing boulders up to 30 cm in diameter in a matrix of volcanic ash and gravel. Apparent isotopic age of the Laguna Springs Volcanic Group, from K-Ar analysis of coexisting biotite and hornblende, is 32.2 ± 1.0 and 32.3 ± 1.0 m.y. (Laughlin and others, 1969). Total thickness 0-640 m

Ttm TINTIC MOUNTAIN VOLCANIC GROUP (OLIGOCENE)—Consists of the Big Canyon Latite, Latite Ridge Latite, and Copperopolis Latite in the East Tintic Mountains (Morris and Lovering, 1979). These three units have similar mineralogic compositions but represent three separate eruptive episodes. Intrusive rocks related to this group are represented by the Sunrise Peak Monzonite Porphyry (Tsps, Tspg). The Big Canyon Latite consists of an upper flow member and a lower tuff member with a combined thickness of 0-60 m. The flow member is medium- to dark-gray, compact, fine-grained latite porphyry characterized by small white plagioclase phenocrysts up to 3 mm long and lustrous granules of pyroxene; the tuff member is buff to white, fine-grained, and moderately to strongly altered to white clay stained yellow, brown, and black by iron and manganese oxides. The Latite Ridge Latite is a distinctive unit consisting of an upper member of welded tuff and a lower member of waterlaid tuff, with a combined thickness of 0-500 m. The welded tuff member is reddish-brown to brownish-black, densely welded, fine grained tuff and medium-grained porphyry containing angular fragments of older rocks and scattered broken crystals in a glassy to cryptocrystalline matrix. The welded tuff is altered locally to white, lavender, and pinkish-brown. The lower member is medium-greenish-gray to white, depending on degree of hydrothermal alteration, medium- to fine-grained non-welded and mostly of uniform texture. The Copperopolis Latite consists of upper and lower agglomerate units separated by flow and tuff units, with a combined thickness of 0-3,800 m; it rests unconformably on the Packard Quartz Latite. East of the Lynndyl quadrangle these units are overlain by additional flow and tuff units indicating a succession of explosive eruptions and quiet extrusions. The upper unit, the middle agglomerate member of Morris (1975), is a massive boulder agglomerate containing rounded clasts of dark-gray latite in a matrix of volcanic gravel and tuff. The next unit, the lower flow member of Morris (1975), is dark-greenish-gray to reddish-brown, fine-grained vitrophyre and fine-grained porphyry, the phenocrysts of labradorite, augite, and hypersthene up to 5 mm long are recognizable only by reflections from their cleavage faces. The underlying tuff member is largely gray-green to white fine- to medium-grained air-fall tuff containing fragments of feldspar, augite, hypersthene, and magnetite crystals in a matrix of comminuted minerals and glass shards. The lower agglomerate member of Morris (1975) is a dark-greenish-gray spatter breccia containing lenses of lapilli and boulder tuff and minor thin flows of dark-gray latite. A whole-rock age determination of the Big Canyon Latite yielded an anomalous age of 35.1 ± 1.4 m.y. (Morris and Lovering, 1979). Combined total thickness is 0 to more than 4,300 m

GOLDENS RANCH FORMATION (OLIGOCENE)—Volcano-sedimentary rocks consisting mainly of agglomerate but containing lenses of conglomerate, sandstone, and algal limestone. Present in southeast corner of map area adjacent to Sage Valley and northeastward in Long Ridge where originally defined by Muessig (1951a, 1951b). Largely temporally correlative with the Tintic Mountain Volcanic Group (Ttm). Divided into

Tgra Agglomerate—Chiefly light-colored weakly cemented volcanic-cobble conglomerate more than 250 m thick. At base includes the pinkish-gray andesite crystal tuff unit of Higgins (1982) which overlies the Canyon Range Formation of Stolle (1978) (TKc) east of the Sevier River. Largely equivalent to the middle agglomerate member of the Copperopolis Latite of the Tintic Mountain Volcanic Group (Ttm) and some of the Laguna Springs Volcanic Group (Tls). Conglomerate cut by numerous east-trending manganese-bearing carbonate veins, some as much as 2 m wide

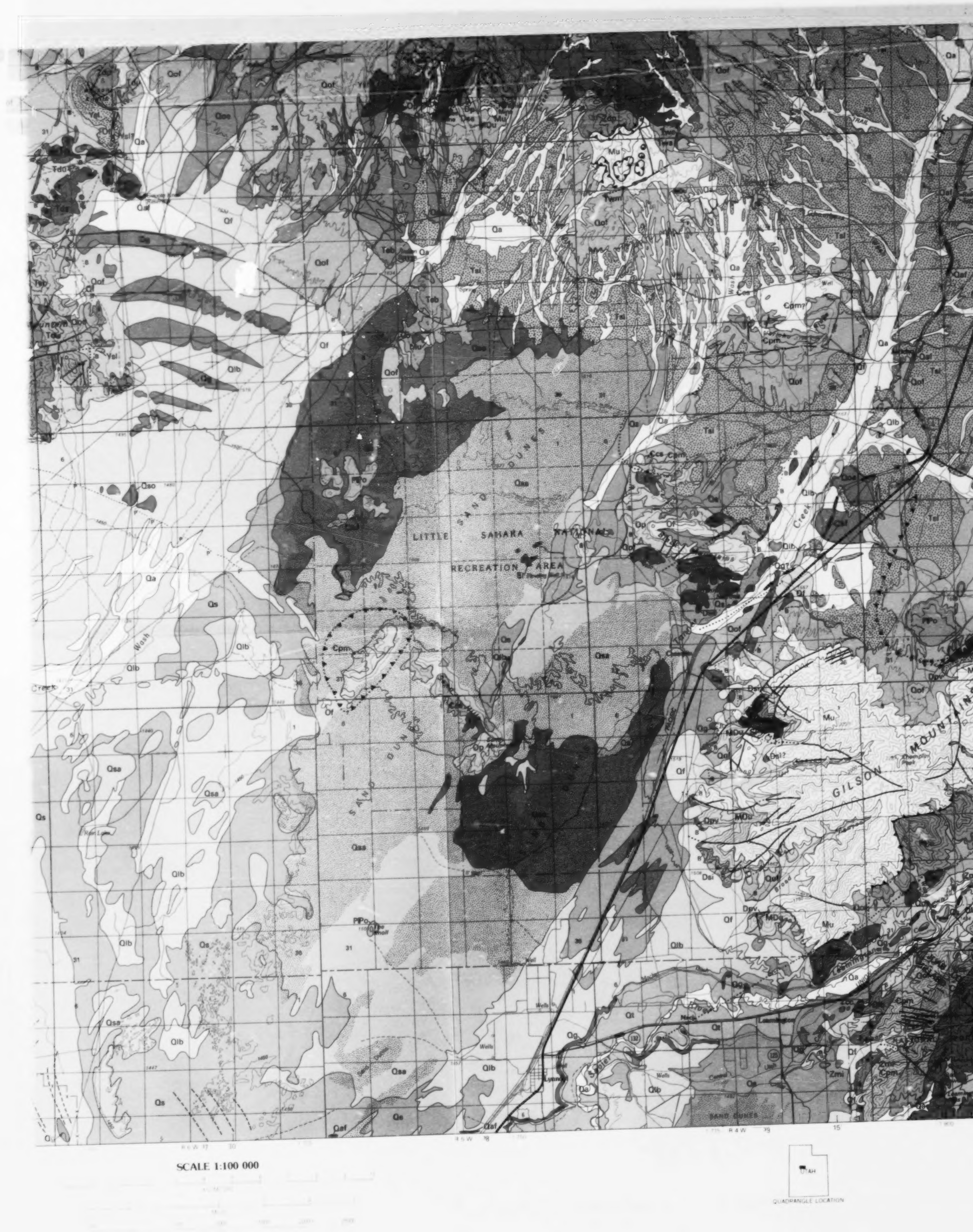
Tgrs Sage Valley Limestone Member—Light- to medium-gray, thin- to medium-bedded algal limestone lenses interbedded with volcanic conglomerate. In Long Ridge the limestone lenses are about 250 m above the basal contact and are as thick as 90 m. Unit of Muessig (1951b)

Tp PACKARD QUARTZ LATITE (OLIGOCENE)—Chiefly pinkish- or lavender-gray medium-grained quartz latite porphyry. Generally divisible into four parts: an upper unit of dark-green to black vitrophyre and tuff as much as 30 m thick; a massive middle unit of quartz latite porphyry locally more than 820 m thick; a lower unit of dark-green to black vitrophyre as much as 60 m thick; and a basal unit of fine-grained tuff as much as 210 m thick (Morris and Lovering, 1979) but averaging less than 10 m thick. Biotite and sanidine from the quartz latite porphyry yielded isotopic ages of 32.8 ± 1.0 and 32.7 ± 1.0 m.y. (Laughlin and others, 1969). Chemically and mineralogically similar to the Swansea Quartz Monzonite (Tsw). Present in the East Tintic Mountains in northeast corner of map area, and is lithologically and temporally equivalent to the Fernow Quartz Latite (Tf) of the southern East Tintic Mountains and Sage Valley area. These two formations are the oldest post-tectonic volcanic units in the East Tintic Mountains. Age is middle Oligocene

Tf FERNOW QUARTZ LATITE (OLIGOCENE)—Light- to medium-gray medium-grained welded tuff containing phenocrysts of quartz, sanidine, andesine, and biotite and flamme of black obsidian in a matrix of partly to wholly welded glass shards. Locally includes thin patches of air-fall tuff at base. Present in the southern East Tintic Mountains and Sage Valley area where it is 0-460 m thick. Lithologically and temporally equivalent to the Packard Quartz Latite (Tp). Age is middle Oligocene

ANDESITIC FLOWS OF DRUM MOUNTAINS (OLIGOCENE)—Dark-green to very-dark-gray porphyritic andesitic flows containing abundant phenocrysts of plagioclase up to 7 mm long, biotite, pyroxene, and hornblende, and dark-gray plagioclase-bearing welded ash-flow tuff containing lithic fragments up to 5 cm long. Thickness varies from 30 to 80 m. Mapped as andesites, undivided, and the tuff of Drum Peak by Dommer (1980) in southwest corner of map area

JOY TUFF (OLIGOCENE AND EOCENE)—In this area consists of the informally named crystal tuff member of Lindsey (1979). Grayish-pink to reddish-brown rhyolitic ash-flow tuff with collapsed black pumice fragments in lower part and light-colored pumice in upper part. Present in Picture Rock Hills and Keg Mountain and westward in southern Thomas Range and northern Drum Mountains (Lindsey, 1979). The average age of the crystal tuff member by eight fission-track dates is 38.0 ± 0.7 m.y. (Lindsey, 1982, p. 7); it is considered to be late Eocene and early Oligocene in age. Mapped as the Red Mountain crystal tuff unit by Staub (1975), which was dated at 36.9 ± 1.7 m.y. by the fission-track method (Lindsey, 1982, table 2), the rhyolitic welded ash-flow tuff unit by Shawe (1972), and includes a part of the Keg Mountain ignimbrites and the viscous flows unit of


LITTLE SAHARA RECREATION AREA
GILSON MOUNTAINS
T 14 S
T 15 S
39°30′
112°00′
Geology compiled and mapped 1981-83
QUADRANGLE LOCATION

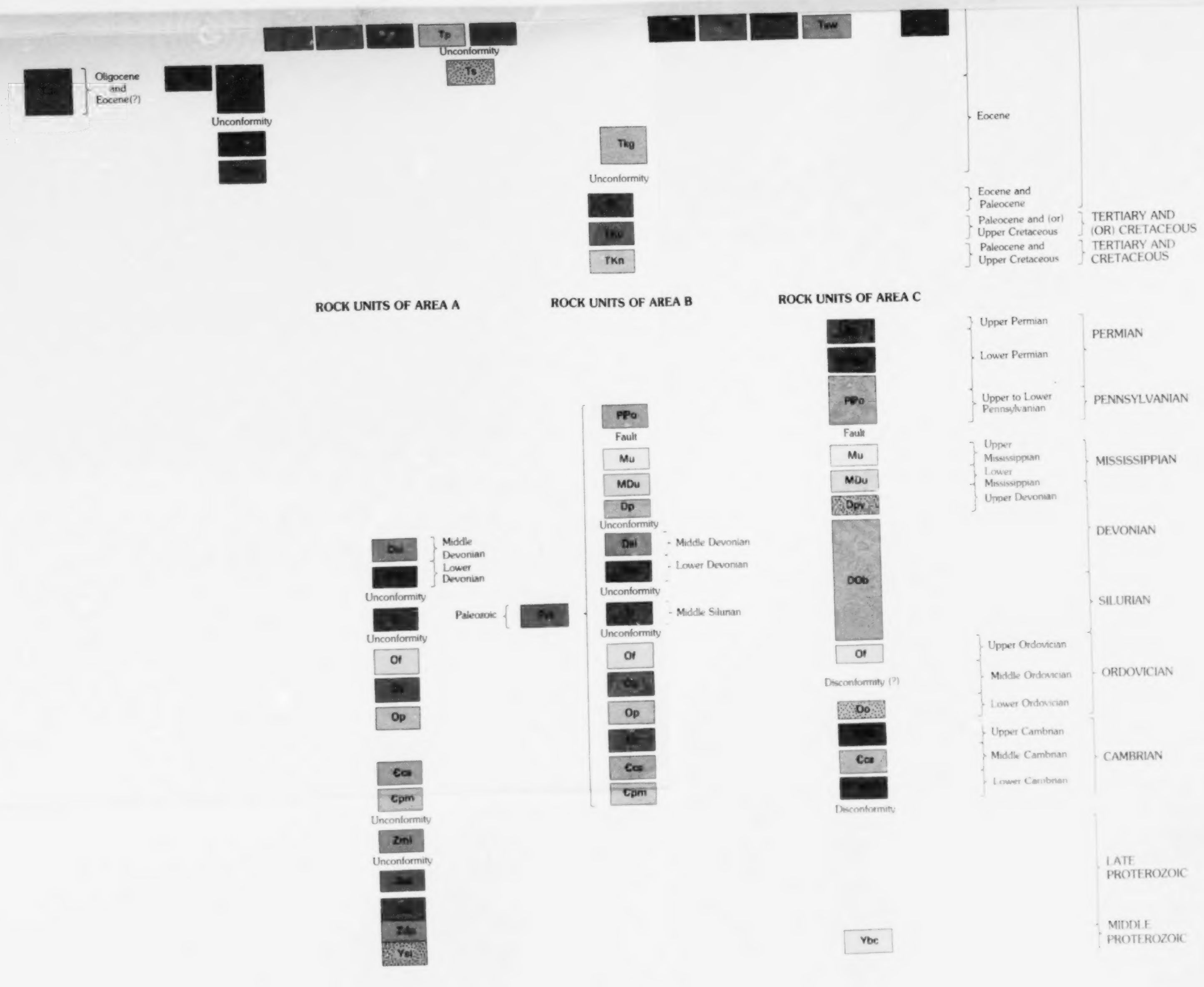
SCALE 1:100 000

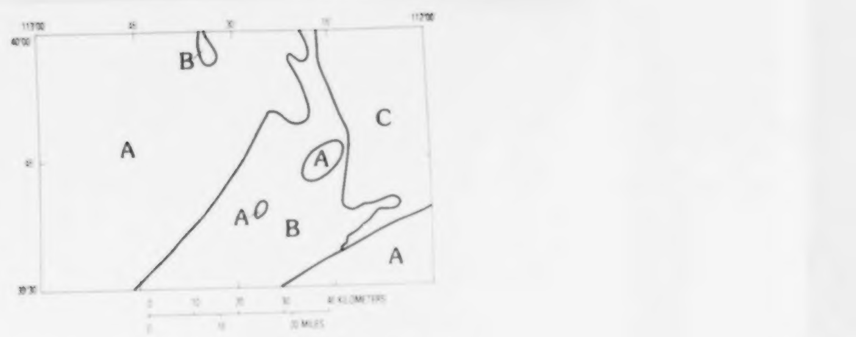
NDYL 30- BY 60-MINUTE QUADRANGLE, WEST-CENTRAL UTAH

By

Earl H. Pampeyan

1989





Index map showing location of areas A, B, and C

ped by Higgins (1982) as the Cretaceous and
Leamington Pass. Locally contains large slide
1,050 m thick
PALEOCENE AND UPPER CRETACEOUS)—
ndstone, siltstone and some silty and sandy
xtreme southeast corner of map

ND SEDIMENTARY ROCKS

(PLEISTOCENE)—Black, fine-grained flows of
rom vesicular to non-vesicular upwards from
s Fumarole Butte flows of Hogg (1972) and
Galyardt and Rush (1981). Overlies lacustrine
rmation; overlain by Lake Bonneville deposits.
0.88 m.y. (Peterson and Nash, 1980) and
nd Rush, 1981). Maximum thickness estimated
marole Butte thinning to a few meters or less

(PLEISTOCENE)—Remnant of cinder cone
source of the basalt of Crater Bench (Qcb).
cinders intruded by fine-grained dense basalt
ded cinders. Locally as much as 50 m thick
(MIOCENE)—Black vesicular tholeiitic basalt
ck that form The Hogback of Crater Bench.
te flow of Hogg (1972), and the basalt of the
Rush (1981). K-Ar age 5.26±0.42 m.y.
and 6.03 m.y. (Peterson and Nash, 1980).
basalt flows unit by Morris (1978). Age is

NE)—Reddish-brown conglomerate and
ining sand- to boulder-size clasts of white to
mounts of dark-gray limestone, and pumice.
nglomerate locally is cemented with calcium
rosion. Thickness of exposed section exceeds
present near base of section and clasts of the
e present near top of section. Mapped only at
as Tertiary conglomerate by Hogg (1972),
and Galyardt and Rush (1981). Age is late

(MIOCENE)—Chiefly light-gray alkali rhyolite
phyre at base of flow units and some white to
ff. Four fission-track and two K-Ar dates of
ge from 6.1±0.4 to 6.8±0.3 m.y. (Lindsey,
ger acidic volcanic rocks unit by Morris (1978).
map divided into the rhyolite of The Hogback
and dikes of Keg Mountain:
ght-gray flow-banded rhyolite with some black
ntain phenocrysts of sanidine up to 4 mm long
large as 2 cm in diameter in the rhyolite are
ystals. Weathers to a coarse irregular vuggy
salt flows (Th) at north tip of Crater Bench.
Equivalent to the rhyolite of The Hogback of
K-Ar dates are 6.87±0.28 m.y. (Mehnert and
(Peterson and Nash, 1980)
es of Keg Mountain—Light-gray to reddish-gray
phanitic to porphyritic rhyolite; some units have
and spherulitic rhyolite, and locally include
ow breccia, tan to white compact friable tuff
and gray quartz latite porphyry containing
uartz, sanidine, and plagioclase. Total thickness
xceed a few hundred meters. These volcanic
the type area in the Thomas Range (Lindsey,
accessory topaz, hematite, bixbyite, and
r amounts than in the type area (Staub, 1975).
uccessive flow units, Tkt_1 being the older,
ff and (or) vitrophyre from the younger Ttk_2
untain rhyolite unit, porphyritic rhyolite of West

Mountain unit, Keg Mountain tuff unit, and Drum Mountain rhyolite unit of Staub (1975) and the rhyolite of Keg Mountain of Shawe (1972, and Lindsey and others (1975) in Keg Mountain, and rhyolite flows of Dommer (1980) in the Drum Mountains. Two fission track dates of flows in Keg Mountain indicate an age of about 8 m.y. (Lindsey, 1979; Lindsey and others, 1975)

Teb EXTRUSIVE BRECCIA (MIOCENE)—Material erupted from breccia pipes (Tib) during early explosive stage consisting of small fragments to large blocks of Precambrian to Tertiary sedimentary and igneous rocks in a matrix of tuffaceous breccia containing shattered crystals of quartz, feldspar, and biotite. Widely exposed in the southern Sheeprock Mountains (Morris and Kopf, 1970b; Morris, 1978) where it may be in excess of 90 m thick; mapped as rhyolite porphyry by Kattleman (1968) and as the diatreme(?) complex by Rees and others (1973) in Desert Mountain where it is exposed over a vertical distance of more than 200 m

Tss SILVER SHIELD QUARTZ LATITE (MIOCENE)—Medium- to dark-gray coarsely porphyritic flows and dikes in northeast corner of map area. Phenocyrsts of plagioclase, quartz, biotite and augite up to 15 mm long are set in a very fine grained to aphanitic matrix with a high proportion of K-feldspar and quartz. The Silver Shield has a maximum thickness of 38 m (Morris and Lovering, 1979). Age is considered middle Miocene based on K-Ar dates ranging from 17.9±0.5 to 18.3±0.5 m.y. (Laughlin and others, 1969). Included in the younger intermediate volcanic rocks unit by Morris (1978)

Tpc PINYON CREEK CONGLOMERATE (MIOCENE)—Grayish-tan to reddish-brown conglomerate composed of sub-angular to rounded, pebble- to boulder-size monolithologic volcanic clasts interlayered with silt- to grit-size volcanic debris. Conspicuously bedded; lensing and channeling are common. Individual beds may be poorly- or well-sorted. The Pinyon Creek Conglomerate is mapped only in the northeast corner of map, where it is more than 300 m thick. Included, along with Miocene conglomerate (Tc) at The Hogback, in the Miocene gravel unit by Morris (1978). Age is early Miocene

JASPEROID (OLIOGCENE?)—Silicified and opalized Tertiary volcanic and Paleozoic carbonate rocks whose origin is apparently related to Oligocene volcanic activity. Includes silicified breccia on southeast side of Gilson Mountains on or near trace of Leamington transcurrent fault

Tjc JUDD CREEK LATITE (OLIGOCENE)—Gray to reddish-brown latite porphyry with phenocrysts of glassy to chalk-white andesine, up to 5 mm long, some quartz, and scarce biotite in a microcrystalline to aphanitic groundmass; the texture is progressively finer grained away from center of outcrop area. Thickness unkown but estimated to be greater than 60 m. Present in the eastern Simpson Mountains, where named the Judd Creek Latite by Thomas (1958), and in the western Sheeprock Mountains; on this map includes several small isolated volcanic outcrops on west side of Simpson Mountains mapped as pitchstone and trachyte by Gilbert (1890). Paleozoic carbonate rocks are silicified locally along contact with overlying latite flows

Tdu UNALTERED EXTRUSIVE ROCKS OF DESERT MOUNTAIN (OLIGOCENE)—Pink to light-greenish-gray rhyolite to quartz latite porphyry with phenocrysts of quartz and K-feldspar in an aphanitic groundmass. Thickness unknown but probably exceeds 140 m. Equivalent to part of Kattelman's (1968) rhyolite porphyry unit, rhyoliltic and quartz-latitic welded ash-flow tuff units of Shawe (1972), and unaltered pyroclastic volcanic rocks unit of Rees and others (1973) in east half of Desert Mountain. Includes small patches of the dark-purple to black quartz latite (dellenite) porphyry unit of Kattelman (1968) in southeastern part of Desert Mountain

LATITE AND QUARTZ LATITE EXTRUSIVE ROCKS OF WEST TINTIC MOUNTAINS (OLIGOCENE)—Chiefly purplish- to brownish-gray, medium-grained porphyritic lava containing phenocrysts of andesine, sanidine, biotite, augite, hornblende, and quartz in a fine-grained to microcrystalline groundmass probably containing much K-feldspar; locally underlain by a white, fine-grained tuff containing shattered crystals of andesine, sanidine, biotite, hornblende, and some quartz (Morris and Kopf, 1970a; 1970b). In places the tuff is argillized and silicified. Present in West Tintic and southern Sheeprock Mountains; total thickness probably exceeds 300 m. In adjacent areas the tuff unit is underlain by regolithic conglomerate (Ts). In western West Tintic Mountains map unit includes some thin tabular intrusive bodies of dark-gray to black, fine-grained olivine basalt

Tls LAGUNA SPRINGS VOLCANIC GROUP (OLIGOCENE)—Consists of the Tintic Delmar Latite, Pinyon Queen Latite, and North Standard Latite in the East Tintic Mountains (Morris and Lovering, 1979), all of which have similar chemical and mineralogical compositions and all contain hornblende which distinguishes them from rocks of the underlying Tintic Mountain Volcanic Group (Ttm). These are the extrusive equivalents of the monzonite porphyry of the Silver City stock (Tsc). The Tintic Delmar Latite consists of an upper flow member and a lower tuff member with a combined thickness of 0-122 m. The flow member is medium-gray to dark-reddish-brown, massive, medium-grained latite porphyry, characterized by large glassy to chalk-white phenocyrsts of feldspar, shiny black biotite crystals, and rare phenocrysts of hornblende and augite; the tuff member is a buff to white fine- to coarse-grained heterogeneous assemblage of volcanic ash, lapilli tuff, and agglomerate containing up to boulder-sized clasts. The Pinyon Queen Latite consists of an upper flow member and lower tuff member, both of which are virtually indistinguishable from their counterparts in the Tintic Delmar Latite, with a combined thickness of 0-335 m. The flow member is medium- to purplish-gray, massive, medium-grained latite porphyry; the tuff member consists of intermixed fine-grained boulder tuff and agglomerate. The North Standard Latite consists of an upper flow member and a lower tuff member with a combined thickness of 0-180 m. The flow member is dull-purplish-gray to brownish-gray, massive fine- to medium-grained porphyry, the freshest outcrops of which show fragments of vitrophyre in a matrix of lighter-colored vitrophyre speckled with glassy to chalk-white phenocrysts of plagioclase and lustrous crystals of biotite; the tuff member is a gray to white heterogeneous agglomerate containing boulders up to 30 cm in diameter in a matrix of volcanic ash and gravel. Apparent isotopic age of the Laguna Springs Volcanic Group, from K-Ar analysis of coexisting biotite and hornblende, is 32.2±1.0 and 32.3±1.0 m.y. (Laughlin and others, 1969). Total thickness 0-640 m

Ttm TINTIC MOUNTAIN VOLCANIC GROUP (OLIGOCENE)—Consists of the Big Canyon Latite, Latite Ridge Latite, and Copperopolis Latite in the East Tintic Mountains (Morris and Lovering, 1979). These three units have similar mineralogic compositions but represent three separate eruptive episodes. Intrusive rocks related to this group are represented by the Sunrise Peak Monzonite Porphyry (Tsps, Tspg). The Big Canyon Latite consists of an upper flow member and a lower tuff member with a combined thickness of 0-60 m. The flow member is medium- to dark-gray, compact, fine-grained latite porphyry characterized by small white plagioclase phenocrysts up to 3 mm long and lustrous granules of pyroxene; the tuff member is buff to white, fine-grained, and moderately to strongly altered to white clay stained yellow, brown, and black by iron and manganese oxides. The Latite Ridge Latite is a distinctive unit consisting of an upper member of welded tuff and a lower member of waterlaid tuff, with a combined thickness of 0-500 m. The welded tuff member is reddish-brown to brownish-black, densely welded, fine-grained tuff and medium-grained porphyry containing angular fragments of older rocks and scattered broken crystals in a glassy to cryptocrystalline matrix. The welded tuff is altered locally to white, lavender, and pinkish-brown. The lower member is medium-greenish-gray to white, depending on degree of hydrothermal alteration, medium- to fine-grained non-welded and mostly of uniform texture. The Copperopolis Latite consists of upper and lower agglomerate units separated by flow and tuff units, with a combined thickness of 0-3,800 m; it rests unconformably on the Packard Quartz Latite. East of the Lynndyl quadrangle these units are overlain by additional flow and tuff units indicating a succession of explosive eruptions and quiet extrusions. The upper unit, the middle agglomerate member of Morris (1975), is a massive boulder agglomerate containing rounded clasts of dark-gray latite in a matrix of volcanic gravel and tuff. The next unit, the lower flow member of Morris (1975), is dark-greenish-gray to reddish-brown, fine-grained vitrophyre and fine-grained porphyry, the phenocrysts of labradorite, augite, and hypersthene up to 5 mm long are recognizable only by reflections from their cleavage faces. The underlying tuff member is largely gray-green to white, fine- to medium-grained air-fall tuff, containing fragments of feldspar, augite, hypersthene, and magnetite crystals in a matrix of cominuted minerals and glass shards. The lower agglomerate member of Morris (1975) is a dark-greenish-gray spatter breccia containing lenses of lapilli and boulder tuff and minor thin flows of dark-gray latite. A whole-rock age determination of the Big Canyon Latite yielded an anomalous age of 35.3±1.4 m.y. (Morris and Lovering, 1979). Combined total thickness is 0 to more than 4,300 m

GOLDENS RANCH FORMATION (OLIGOCENE)—Volcano-sedimentary rocks consisting mainly of agglomerate but containing lenses of conglomerate, sandstone, and algal limestone. Present in southeast corner of map area adjacent to Sage Valley and northeastward in Long Ridge where originally defined by Muessig (1951a, 1951b). Largely temporally correlative with the Tintic Mountain Volcanic Group (Ttm). Divided into:

Tgra Agglomerate—Chiefly light-colored weakly cemented volcanic-cobble conglomerate more than 250 m thick. At base includes the pinkish-gray andesite crystal tuff unit of Higgins (1982) which overlies the Canyon Range Formation of Stolle (1978) (TKc) east of the Sevier River. Largely equivalent to the middle agglomerate member of the Copperopolis Latite of the Tintic Mountain Volcanic Group (Ttm) and some of the Laguna Springs Volcanic Group (Tls). Conglomerate cut by numerous east-trending manganese-bearing carbonate veins, some as much as 2 m wide

Sage Valley Limestone Member—Light- to medium-gray, thin- to medium-bedded algal limestone lenses interbedded with volcanic conglomerate. In Long Ridge the limestone lenses are about 250 m above the basal contact and are as thick as 90 m. Unit of Muessig (1951b)

Tp PACKARD QUARTZ LATITE (OLIGOCENE)—Chiefly pinkish- or lavender-gray medium-grained quartz latite porphyry. Generally divisible into four parts: an upper unit of dark-green to black vitrophyre and tuff as much as 50 m thick; a massive middle unit of quartz latite porphyry locally more than 820 m thick; a lower unit of dark-green to black vitrophyre as much as 60 m thick; and a basal unit of fine-grained tuff as much as 210 m thick (Morris and Lovering, 1979) but averaging less than 10 m thick. Biotite and sanidine from the quartz latite porphyry yielded isotopic ages of 32.8±1.0 and 32.7±1.0 m.y. (Laughlin and others, 1969). Chemically and mineralogically similar to the Swansea Quartz Monzonite (Tsw). Present in the East Tintic Mountains in northeast corner of map area, and is lithologically and temporally equivalent to the Fernow Quartz Latite (Tf) of the southern East Tintic Mountains and Sage Valley area. These two formations are the oldest post-tectonic volcanic units in the East Tintic Mountains. Age is middle Oligocene

FERNOW QUARTZ LATITE (OLIGOCENE)—Light- to medium-gray medium-grained welded tuff containing phenocrysts of quartz, sanidine, andesine, and biotite and fiamme of black obsidian in a matrix of partly to wholly welded glass shards. Locally includes thin patches of air-fall tuff at base. Present in the southern East Tintic Mountains and Sage Valley area where it is 0-460 m thick. Lithologically and temporally equivalent to the Packard Quartz Latite (Tp). Age is middle Oligocene

ANDESITIC FLOWS OF DRUM MOUNTAINS (OLIGOCENE)—Dark-green to very-dark-gray porphyritic andesitic flows containing abundant phenocrysts of plagioclase up to 7 mm long, biotite, pyroxene, and hornblende, and dark-gray plagioclase-bearing welded ash-flow tuff containing lithic fragments up to 5 cm long. Thickness varies from 30 to 80 m. Mapped as andesites, undivided, and the tuff of Drum Peak by Dommer (1980) in southwest corner of map area

JOY TUFF (OLIGOCENE AND EOCENE)—In this area consists of the informally named crystal tuff member of Lindsey (1979). Grayish-pink to reddish-brown rhyolitic ash-flow tuff with collapsed black pumice fragments in lower part and light-colored pumice in upper part. Present in Picture Rock Hills and Keg Mountain and westward in southern Thomas Range and northern Drum Mountains (Lindsey, 1979). The average age of the crystal tuff member by eight fission-track dates is 38.0±0.7 m.y. (Lindsey, 1982, p. 7); it is considered to be late Eocene and early Oligocene in age. Mapped as the Red Mountain crystal tuff unit by Staub (1975), which was dated at 36.9±1.7 m.y. by the fission-track method (Lindsey, 1982, table 2), the rhyolitic welded ash-flow tuff unit by Shawe (1972), and includes a part of the Keg Mountain Ignimbrites and the viscous flows unit of Erickson (1963). As mapped, the unit near Keg Pass includes ignimbrites assigned to the Oligocene Dell Tuff whose average age by fission-track methods is 32.0±0.6 m.y. (Lindsey, 1982, table 2). As much as 150 m thick

Ts PREVOLCANIC SEDIMENTARY DEPOSITS (OLIGOCENE)—Chiefly fanglomerate and alluvium on east side of the Canyon Mountains and southeast side of Sage Valley but also includes small patches of conglomerate and volcanic gravels in the West Tintic Mountains and the Apex Conglomerate in the East Tintic Mountains. Locally exceeds 90 m in thickness

ALTERED EXTRUSIVE ROCKS OF DESERT MOUNTAIN (OLIGOCENE AND EOCENE?)—Pyroclastic acidic volcanic rocks in northeast Desert Mountain and Allison Knolls. Thickness unknown but probably exceeds 120 m. Strongly argillized and silicified; locally mapped as jasperoid (j). Equivalent to part of the rhyolite porphyry unit of Kattelman (1968) and the rhyolitic and quartz-latitic welded ash-flow tuff units of Shawe (1972), and correlated with part of the crystal tuff member of the Joy Tuff (Tj) (Lindsey, 1979; Lindsey and others, 1975). The crystal tuff member here was dated at 34.5±1.3 m.y. by the fission-track method on zircon but this age probably is too young because the tuff has been intruded by granitic rocks of Desert Mountain, an event that may have slightly reset the zircon age (Shawe, 1972; Lindsey, 1982)

LATITIC FLOWS OF KEG MOUNTAIN (EOCENE)—Porphyritic andesite and latite flows and pyroclastic rocks containing phenocrysts of K-feldspar, biotite, and hornblende. Thickness estimated at 45 to 75 m. Weathers to brown soil. Includes upper part of the Keg Spring Andesite and Keg Spring Latite of Erickson (1963) and the latitic, andesitic, and basaltic flows and agglomerates unit of Shawe (1972)

LATITIC, ANDESITIC, AND BASALTIC FLOWS OF KEG MOUNTAIN (EOCENE)—Dark latite, dark rhyodacite, andesite, and andesitic basalt flows and agglomerates. Thickness estimated to be in excess of 225 m. Includes lower part of the Keg Spring Andesite and Keg Spring Latite of Erickson (1963) and the latitic, andesitic, and basaltic flows and agglomerates unit of Shawe (1972), and part of the Keg Spring Andesite unit of Staub (1975)

INTRUSIVE ROCKS

Tib INTRUSIVE BRECCIA (MIOCENE)—Breccia pipes in the West Tintic and Sheeprock Mountains containing minute fragments to large blocks of Precambrian to Tertiary sedimentary and igneous rocks in a matrix of intrusive arkosic tuff (Morris and Kopf, 1967), and in the East Tintic Mountains containing blocks of quartzite, limestone, and shale in a weakly pyritized matrix of shattered quartz, sanidine and plagioclase fragments and rock flour (Morris, 1975). The largest pipe, in the West Tintic Mountains, is more than 6,700 m long and 2,000 m wide

INTRUSIVE RHYOLITE DIKES AND DOMES OF KEG MOUNTAIN (MIOCENE)—Porphyritic rhyolite plugs and large dikes in the southern part of Keg Mountain (Staub, 1975). The plugs are 500 to 800 m across and the dikes are up to 50 m wide and 600 m long. Included in younger granitic rocks unit of Morris (1978)

Tsg GRANITE OF SHEEPROCK MOUNTAINS (MIOCENE)—White to light-gray, medium- to coarse-grained porphyritic granite, commonly limonite stained. Phenocrysts of orthoclase 12 to 35 mm in diameter are uniformly distributed in a matrix of gray quartz, microcline, and a little biotite. Most of the granite is stained red-brown but a small central core is less stained than the surrounding granite; the whiter granite contains a small percentage of crystalline beryl disseminated throughout. Includes pegmatite and aplite dikes and greisenized fracture zones containing tungsten minerals and samarskite in addition to beryl. Informally referred to as the Sheeprock granite by Cohenour (1959). Dated at 15 and 17 m.y. (Cohenour, 1959) and 16.7±0.3 m.y. by the K-Ar method (Armstrong, 1970)

QUARTZ LATITE STOCKS OF KEG MOUNTAIN (OLIGOCENE)—Intrusive quartz latite, quartz monzonite, and breccia as dikes and small plugs (Shawe, 1972). Generally porphyritic with phenocrysts of quartz, plagioclase, sanidine, and biotite in a devitrified groundmass. One intrusive quartz latite plug dated by fission-track methods at 30.8±1.8 m.y. (Lindsey and others, 1975)

LEUCOGRANITE PORPHYRY OF DESERT MOUNTAIN (OLIGOCENE)—Light-gray to white granite with prominent pink K-feldspar phenocrysts up to 15 mm long. Intrusive relations show the leucogranite porphyry to be younger than the granodiorite of Desert Mountain (Tdg). Dated by the fission-track method at 28.2 and 32.4 m.y. (Lindsey and others, 1975) and the K-Ar method at 26.5±0.5 and 28.5±0.6 m.y. (Armstrong, 1970). Same as the leucogranite porphyry and alaskite porphyry unit of Kattelman (1968), the granite and sanded-altered volcanic rocks unit of Rees and others (1973), and the quartz monzonite of Desert Mountain of Shawe (1972). Includes alaskite and lamprophyre dikes as much as 9 m wide

INTRUSIVE ROCKS OF SIMPSON MOUNTAINS (OLIGOCENE)—Numerous mostly dark-colored, but some light-gray to tan, small porphyritic plugs and dikes containing feldspar and quartz phenocrysts up to 10 mm long set in an aphanitic to microcrystalline groundmass. Individual intrusive bodies tentatively determined to be of latitic, rhyolitic, and basaltic composition (Thomas, 1958). Map unit Tsi is equivalent to the intrusive rocks unit of Thomas (1958); some intrusive bodies may represent feeders of the Judd Creek Latite (Tjc) of Thomas (1958)

GRANODIORITE OF DESERT MOUNTAIN (OLIGOCENE)—Dark-colored, generally porphyritic granodiorite with light-colored phenocrysts up to 3 mm long in a microcrystalline groundmass. Same as the granodiorite and adamellite unit of Kattelman (1968), the granodiorite unit of Rees and others (1973), and included in the latitic, andesitic, and basaltic flows and agglomerates unit by Shawe (1972)

Twe ANDESITE INTRUSION BRECCIA OF WEST TINTIC MOUNTAINS (OLIGOCENE)—Subrounded, cobble-sized fragments of dark-reddish-brown fine-grained andesite, monzonite porphyry, quartzite, and carbonate rocks in a sparse matrix of hematite-stained pulverized andesite (Morris and Kopf, 1970a). Occurs in the southernmost West Tintic Mountains

MONZONITIC STOCKS OF WEST TINTIC MOUNTAINS (OLIGOCENE)—Stocks, plugs, and dikes of monzonite porphyry, quartz monzonite porphyry, quartz monzonite, and intrusive latite and quartz latite porphyry in the southern Sheeprock and West Tintic Mountains. Includes the Orient, Oro Plata, and West Tintic stocks of Morris and Kopf (1970a; 1970b)

MONZONITE PORPHYRY STOCK OF SILVER CITY (OLIGOCENE)—Medium-to light-pinkish or purplish-gray, medium- to fine-grained porphyritic monzonite, most of which has undergone propylitic alteration. Stock has an outcrop area of about 7.8 km^2 in the East Tintic Mountains. Dikes and sills with similar composition are present in the area surrounding the stock. Phenocyrsts of feldspar, biotite, hornblende, and augite up to 10 mm long are set in a dense to fine-grained groundmass of K-feldspar and quartz with minor amounts of plagioclase feldspar and ferromagnesian minerals. The monzonite has an age of 31.5±0.9 m.y. (Laughlin and others, 1969) and is the intrusive equivalent of the Laguna Springs Volcanic Group (Tls). Age is middle Oligocene

SUNRISE PEAK MONZONITE PORPHYRY (OLIGOCENE)—Medium- to dark- gray, coarsely porphyritic stocks, plugs, sills, and dikes containing phenocrysts of augite, hypersthene, biotite, labradorite, and orthoclase in an aphanitic groundmass. Widely exposed in the East Tintic Mountains and closely related to the extrusive rocks of the Tintic Mountain Volcanic Group (Ttm) (Morris and Lovering, 1979, p. 36). Age is middle Oligocene. Divided into:

Sunrise Peak stock—Stock, plugs, dikes, and other large steeply dipping bodies. Large map unit (Tsps?) south of Sunrise Peak stock includes plugs and dikes of latite porphyry that may be the eruptive source of the Tintic Mountain Volcanic Group (Morris, 1975)

Gough and Dry Ridge sills—Gently east-dipping intrusive bodies originally part of a single sheet derived from the Sunrise Peak stock (Morris, 1975; Morris and Lovering, 1979)

SWANSEA QUARTZ MONZONITE (OLIGOCENE)—Pale-grayish-pink to grayish-green to buff and white, depending on degree of freshness and type of alteration, fine- to medium-grained, granitic to porphyritic quartz monzonite. Nearly identical to the Packard Quartz Latite (Tp) in chemistry and mineralogy (Morris, 1975) and relative age. The Swansea stock lies between Silver City and Mammoth in the East Tintic Mountains

BASALT SILLS OF GILSON MOUNTAINS (OLIGOCENE)—Black porphyritic basalt containing strongly zoned phenocrysts of labradorite in a matrix of plagioclase microlites and glass. Present on southeast side of Gilson Mountains as sills in the section composed of the Oquirrh Group (PPo) and Diamond Creek Sandstone (Pdc). Intrusive rocks of Higgins (1982). Up to 50 m thick

Tkg GRANODIORITE STOCKS OF KEG MOUNTAIN (EOCENE)—Gray-green massive granodiorite porphyry containing phenocrysts of plagioclase, biotte, and quartz in a microcrystalline groundmass, and dark- to medium gray massive diorite porphyry with phenocrysts of plagioclase and biotite. Includes rocks resembling rhyolite porphyry mapped as the Keg Mountain Ignimbrites by Erickson (1963), the quartz-latitic welded ash-flow tuff unit by Shawe (1972), the Keg granodiorite porphyry unit and the diorite porphyry part of the Keg Spring Andesite of Staub (1975)

ROCK UNITS OF AREA A

Dsi SIMONSON DOLOMITE (MIDDLE DEVONIAN)—Medium- and dark-brownish-gray, coarse- to medium-grained, color-banded dolomite. Present in the southern Sheeprock Mountains, where it contains a dolomite megabreccia lens 122 m thick, and in the Gilson and eastern Simpson Mountains. Unconformity at top cuts out the Guilmette Formation in the West Tintic Mountains. Thickness ranges from 60 to 260 m

SEVY DOLOMITE (LOWER DEVONIAN)—Grayish-white-weathering, light-gray, fine-grained to dense dolomite, containing scattered grains of frosted clear quartz. Present in the east part of the Simpson Mountains, and in the Sheeprock, Black, and Gilson Mountains. About 370 m thick

LAKETOWN DOLOMITE (MIDDLE SILURIAN)—Gray, aphanitic to coarse-grained, medium- to thick-bedded, faintly laminated dolomite; dark- to medium-gray, medium- to coarse-grained, thin-bedded crystalline cherty dolomite containing one or more stromatolitic horizons. Present west and south of the East Tintic Mountains in the upper plate of the Tintic Valley thrust fault. Thickness ranges from about 150 m in southern East Tintic Mountains to 430 m in southern Sheeprock Mountains

Of FISH HAVEN DOLOMITE (UPPER ORDOVICIAN)—Light- to dark-gray, thin to massive-bedded, medium- to coarse-grained cherty dolomite, with a massive ledge-forming mottled granular dolomite bed at top. Present in east two-thirds of map area. Thickness increases westward from 60 m in East Tintic Mountains to 245 m in southern Sheeprock Mountains

Os SWAN PEAK FORMATION (MIDDLE ORDOVICIAN)—Chiefly white to tan, medium-grained, well-sorted quartzite, with some beds and pockets of sandstone and some reddish and greenish phosphatic quartzite at the base. Apparently lenses-out eastward and southward; present only in the Simpson and Sheeprock Mountains. Maximum thickness is about 215 m

Op POGONIP GROUP (MIDDLE AND LOWER ORDOVICIAN)—Chiefly light blue-gray, thin- to medium-bedded, fine-grained, silt-streaked limestone containing flat-pebble conglomerate layers, and locally includes an upper unit of shale, the Middle Ordovician Kanosh Shale. Present in and south of the Sheeprock Mountains, in upper plate of the Tintic Valley thrust fault. More than 850 m thick in southern Sheeprock Mountains

Ccs CARBONATE AND CLASTIC SEDIMENTARY ROCKS (MIDDLE CAMBRIAN)—Chiefly light- to dark-gray limestone and dolomite with some shale intervals. Consists of the Pierson Cove Formation, Wheeler Shale, Swasey Limestone, Whirlwind Formation, Dome Limestone, Chisholm Formation, Howell Limestone, and upper or Tatow Member of the Pioche Formation in the western and southern parts of map area (Dommer, 1980; Higgins, 1982), all or part of the Cole Canyon Dolomite, Marjum Formation, Wheeler Formation, Swasey Limestone, Whirlwind Formation, Dome Limestone, Chisholm Shale, Howell Limestone, and Tatow Member in the Sheeprock Mountains (Christie-Blick, 1983), and the Cole Canyon Dolomite, Bluebird Dolomite, Herkimer Limestone, Dagmar Dolomite, Teutonic Limestone and Ophir Formation in the East Tintic Mountains (Morris and Lovering, 1979). Thickness ranges from 515 m in East Tintic Mountains to 1,150 m in Sheeprock Mountains

Cpm PROSPECT MOUNTAIN QUARTZITE (LOWER CAMBRIAN)—White to light red, fine- to medium-grained, thick- to massive-bedded, moderately feldspathic, commonly cross-bedded quartzite. Pebble beds are present in lower part of the formation, and locally the upper part is shaly. As mapped, unit includes all rocks assigned to the Pioche Formation in the Sheeprock Mountains by Blick (1979) and in the Simpson Mountains by Thomas (1958) and to the lower part of the Pioche in the Drum Mountains by Dommer (1980) and in the Canyon Mountains by (Higgins, 1982). Thickness is 835 m in the Canyon Mountains, about 855 m in the Simpson Mountains, and 1,350 m in the Sheeprock Mountains

Zmi MUTUAL AND INKOM FORMATIONS, UNDIVIDED (LATE PROTEROZOIC)—The Mutual is predominantly light-pink to a distinctive purplish-red, poorly sorted, fine- to coarse-grained feldspathic quartzite, grit and metaconglomerate, locally including a purplish-red argillite bed near the base; the Inkom is predominantly grayish-green to brownish-gray, silty shale and siltstone, locally containing quartzite and pebble conglomerate layers. Well exposed in the Drum, Simpson, Canyon, and Sheeprock Mountains. The Mutual is about 915 m thick in the Drum Mountains (Dommer, 1980), 430-510 m in the Sheeprock Mountains (Christie-Blick, 1982), and about 500 m in the Canyon Mountains (Higgins, 1982). The Inkom Formation ranges in thickness from 90 m in the Canyon Mountains (Higgins, 1982), to 30-145 m in the Sheeprock Mountains (Christie-Blick, 1982), and 160 m in the Drum Mountains (Dommer, 1980)

CADDY CANYON QUARTZITE (LATE PROTEROZOIC)—White to pinkish, brown, and gray, fine- to coarse-grained vitreous quartzite with some interbeds of olive-green to purplish-red phyllitic argillite, siltstone, and fine-grained quartzite. Present in the Drum, Simpson, Sheeprock, and Gilson Mountains; sections exposed in the Drum and Gilson Mountains are less-well sorted and coarser grained, largely being grit and pebble conglomerate. As much as 2,000 m thick in the Sheeprock (Christie-Blick, 1982) and Gilson (Higgins, 1982) Mountains; in the Drum Mountains only 170 m of the Caddy Canyon Quartzite is exposed beneath the Inkom Formation (Dommer, 1980)

SHEEPROCK GROUP OF CHRISTIE-BLICK (1982) (LATE AND MIDDLE PROTEROZOIC)—A sequence of phyllite, quartzite, glaciomarine diamictite, and shale, 2,700 to 4,300 m thick. Consists of:

KELLEY CANYON FORMATION (LATE PROTEROZOIC)—Olive-green to gray, locally micaceous and laminated shale with lesser amounts of green to tan, very fine- to fine-grained sandstone and quartzite. Present in the Sheeprock Mountains where it is 155 to 575 m thick (Christie-Blick, 1982)

DUTCH PEAK FORMATION (LATE PROTEROZOIC)—Chiefly dark-olive-green to brown diamictite of glacial origin, graywacke, and conglomerate with some interbeds of slate, argillite, quartzite, grit, and greenstone flows. Clasts in the diamictite are chiefly dropstones that range from sand- to boulder-size, and commonly are rounded; they consist mainly of granitic and carbonate rocks, quartzite, and schist. Exposed only in the Sheeprock Mountains. Equivalent to the Dutch Peak Tillite of Cohenour (1959). As much as 3,750 m thick in the Sheeprock Mountains. Unit of Christie-Blick (1982)

LOWER PART (MIDDLE PROTEROZOIC)—Chiefly gray to tan, fine-to medium-grained vitreous quartzite with interbeds of conglomerate and grit and some diabase sills, green to black diamictite, and silver-gray to greenish-black phyllitic argillite containing some sandstone interbeds. Extensively exposed in the Simpson and Sheeprock Mountains and Allison Knolls. Includes small quartzite exposure on east side of Desert Mountain questionably assigned to the lower Sheeprock Series by Kattelman (1968). Equivalent to the Otts Canyon Formation of Christie-Blick (1982) in the Sheeprock Mountains where it is as much as 2,200 m thick; the section comprising the lower part of the Sheeprock Group is substantially thicker in the Simpson Mountains (H.T. Morris, unpubl. data, 1985)

ROCK UNITS OF AREA B

OQUIRRH GROUP (LOWER PERMIAN TO LOWER PENNSYLVANIAN)—Blue-gray, medium-bedded cherty silty limestone, gray, medium-bedded to massive, medium-grained cherty dolomite, red-brown-weathering, fine-grained sandstone and quartzite, medium- to dark-gray, medium-bedded cherty and silty limestone, and medium blue gray, thin- to medium-bedded silty and sandy limestone interlayered in various combinations. Consists of the West Canyon and Furner Valley Limestones and the Butterfield Peaks and Bingham Mine Formations in the southern East Tintic Mountains (Morris and others, 1977). Exposed only in east half of map area. Fossiliferous sandy carbonate rocks forming The Knoll northwest of Lynndyl are questionably assigned to the lowermost part of the Oquirrh Group but may belong to the uppermost part of the Humbug Formation. Only lower or Pennsylvanian part of the Oquirrh is exposed in the West Tintic Mountains. About 5,000 m thick in southern East Tintic Mountains, about 1,700 m of section exposed in Gilson Mountains

Mu GREAT BLUE AND HUMBUG FORMATIONS AND DESERET LIMESTONE, UNDIVIDED (UPPER MISSISSIPPIAN)—Chiefly blue-gray cherty limestone, light-gray limestone interlayered with medium- to coarse-grained quartzitic sandstone, blue-gray, medium- to thick-bedded cherty limestone, and locally with thick units of quartzitic sandstone and fissile carbonaceous and phosphatic shale. Present in east half of map area. As much as 1,340 m thick in East Tintic Mountains

MDu GARDISON LIMESTONE (LOWER MISSISSIPPIAN) AND FITCHVILLE FORMATION (LOWER MISSISSIPPIAN AND UPPER DEVONIAN), UNDIVIDED—Chiefly prominently bedded, dark- to medium-blue-gray partly cherty limestone with abundant well-preserved fossils, and some blue argillaceous limestone, massive light-gray to white medium-grained limestone, blue-gray, thin-bedded shaly limestone, dusky-blue-gray, massive cherty dolomite, quartzite, pinkish-gray sub-lithographic limestone, and medium- to dark-gray, dense stromatolitic limestone. Present in east half of map area. The Gardison is wholly Early Mississippian. The Fitchville, as exposed in the East Tintic Mountains, is Early Mississippian and Late Devonian. In the Gilson and southern Sheeprock Mountains the Fitchville was thought to be wholly Early Mississippian but may contain Late Devonian strata. No Fitchville is present in unit MDu in the southern West Tintic Mountains. As much as 300 m thick in southern East Tintic Mountains

Dp PINYON PEAK LIMESTONE (UPPER DEVONIAN)—Medium- to dark-blue massive limestone streaked with tan to light-brown silt and clay with a lower unit of buff to light-brown medium-grained massive quartzite. As mapped includes the Allah Quartzite of Stringham (1942) in the southern Sheeprock Mountains. Maximum thickness is about 75 m

Dsi SIMONSON DOLOMITE (MIDDLE DEVONIAN)—See description under Area A

SEVY DOLOMITE (LOWER DEVONIAN)—See description under Area A

Sl LAKETOWN DOLOMITE (MIDDLE SILURIAN)—See description under Area A

Of FISH HAVEN DOLOMITE (UPPER ORDOVICIAN)—See description under Area A

Os SWAN PEAK FORMATION (MIDDLE ORDOVICIAN)—See description under Area A

Op POGONIP GROUP (MIDDLE AND LOWER ORDOVICIAN)—See description under Area A

Cc CARBONATE ROCKS, UNDIVIDED (UPPER CAMBRIAN)—Dark-gray, thin- to thick-bedded limestone, argillaceous limestone, dolomite, and oolitic, pebbly, and cherty limestones, pisolitic dolomite, and light-green fissile shale, and intraformational conglomerate. In the Sand Hills and Black Mountains equivalent to the Notch Peak (part) and Orr Formations and Weeks Limestone (part). Approximately the same age as the undivided Ajax Dolomite and Opex Formation (Cao) in the East Tintic Mountains

Ccs CARBONATE AND CLASTIC SEDIMENTARY ROCKS (MIDDLE CAMBRIAN)—see description under Area A

Cpm PROSPECT MOUNTAIN QUARTZITE (LOWER CAMBRIAN)—See description under Area A

Pzc CARBONATE ROCKS, UNDIVIDED (PALEOZOIC)—Present as a small thrust slice in the West Tintic Mountains

ROCK UNITS OF AREA C

PARK CITY FORMATION (UPPER AND LOWER PERMIAN)—Chiefly gray, medium-bedded, cherty dolomite of the Lower Permian Franson and Grandeur Members of the Park City Formation separated by a brownish-black, thin-bedded cherty phosphatic mudstone tongue of the Meade Peak Member of the Phosphoria Formation (Morris, 1977). Exposed in southern East Tintic and Gilson Mountains in the lower plate of the Tintic Valley thrust fault where it is 470 to 570 m thick

DIAMOND CREEK SANDSTONE (LOWER PERMIAN)—Largely white to red, massive, friable, cross-bedded, calcareous sandstone with interlayered gray to pink dolomite, limestone, and sandy dolomite. Exposed in southern East Tintic and eastern Gilson Mountains in the lower plate of the Tintic Valley thrust fault. About 260 m thick

PPo OQUIRRH GROUP (LOWER PERMIAN TO LOWER PENNSYLVANIAN)—See description under Area B

Mu GREAT BLUE AND HUMBUG FORMATIONS AND DESERET LIMESTONE, UNDIVIDED (UPPER MISSISSIPPIAN)—See description under Area B

MDu GARDISON LIMESTONE (LOWER MISSISSIPPIAN) AND FITCHVILLE FORMATION (LOWER MISSISSIPPIAN AND UPPER DEVONIAN)—See description under Area B

Dpv PINYON PEAK LIMESTONE AND VICTORIA FORMATION, UNDIVIDED (UPPER DEVONIAN)—Light-blue-gray to dark-blue, fine-grained, thin-bedded to massive, silt-streaked limestone, buff to light-brown, medium-grained, massive sandstone and quartzite, and medium-gray, medium-bedded interlayered dolomite and sandstone. Present in the East Tintic Mountains; also present in the Gilson Mountains (Morris, 1978) in the upper plate of the Tintic Valley thrust fault. Combined thickness is 60 to 130 m

DOb BLUEBELL DOLOMITE (DEVONIAN, SILURIAN, AND UPPER ORDOVICIAN)—Medium- to dark-gray, medium- to thick-bedded, medium- to coarse-grained, moderately fossiliferous, locally mottled and cherty dolomite, with a prominent stromatolitic horizon near the middle and medium-gray, thin- to medium-bedded, fine-grained laminated dolomite. Silurian part of the Bluebell is lithologically equivalent to the Laketown Dolomite. Formation is recognized only in the East Tintic Mountains. Thickness ranges from about 100 to 230 m

Of FISH HAVEN DOLOMITE (UPPER ORDOVICIAN)—See description under Area A

Oo OPOHONGA LIMESTONE (LOWER ORDOVICIAN)—Light-bluish-gray, thin-bedded argillaceous limestone containing much flat-pebble conglomerate with nodules of white chert in the lower limestones, and a thin basal unit of sandstone. Present in the East Tintic Mountains where it is 90-305 m thick

AJAX DOLOMITE AND OPEX FORMATION, UNDIVIDED (UPPER CAMBRIAN)—Medium- to dark-gray, partly mottled, medium-bedded cherty dolomite, creamy-white, medium- and coarse-grained massive dolomite, medium- to dark-gray, massive-bedded cherty dolomite, and light-gray, thin-bedded limestone, shale, sandstone and dolomite. Present in northeast corner of map, in the lower plate of the Tintic Valley thrust, where it is 225-310 m thick

Ccs CARBONATE AND CLASTIC SEDIMENTARY ROCKS (MIDDLE CAMBRIAN)—See description under Area A

TINTIC QUARTZITE (LOWER CAMBRIAN)—White to buff, medium-grained, well-bedded to massive quartzite, shaly at top and conglomeratic at base. Contains an altered basalt flow as much as 12 m thick about 300 m above base. Present in northeast corner of map area in the East Tintic Mountains where maximum thickness is 975 m

Ybc BIG COTTONWOOD FORMATION (MIDDLE PROTEROZOIC)—Predominantly olive-green to brown phyllitic shale and medium- to coarse-grained quartzite containing a lens of brown-weathering fine-grained dolomitic limestone. These rocks are here assigned to the Big Cottonwood Formation but may prove to be equivalent to Late Proterozoic rocks of the Sheeprock Mountains. Upper part of section present in the northeast corner of map area. More than 560 m thick

best copy available

DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

TO ACCOMPANY MAP I–1830

NEW YORK
SEP 13 1989
STATE LIBRARY

GEOLOGIC MAP OF THE LYNNDAL 30- BY 60-MINUTE QUADRANGLE, WEST-CENTRAL UTAH

By Earl H. Pampeyan

INTRODUCTION

The Lynndyl 30- by 60-minute 1:100,000-scale quadrangle is located in west-central Utah at the eastern edge of the Great Basin (fig. 1). The Sevier River, which drains part of the western Colorado Plateaus province, flows through the southeast corner of the quadrangle and terminates at Sevier Lake. The rocks and sediments exposed in the quadrangle represent a fairly complete sequence ranging in age from Middle Proterozoic to Holocene excluding most of the Mesozoic, which is present to the east in the Colorado Plateaus. The presence of major ore deposits in the East Tintic Mountains stimulated geologic interest in this region, and early stratigraphic work was concentrated around the Tintic ore deposits. Tower and Smith (1899), Crane (1917), and Lindgren and Loughlin (1919) established the basic geologic framework that stood for many years. Subsequent updating of the stratigraphy by Morris and Lovering (1961; 1979), Morris (1978), and Christie-Blick (1982) and the regional structure by Morris (1983) and Christie-Blick (1983) is shown on this map.

Geologic data for the bedrock areas of the Lynndyl 30- by 60-minute quadrangle were compiled from a variety of published and unpublished sources, many of which were used by Morris (1978) in his compilation of the Delta 2° quadrangle (see index to geologic mapping, fig. 2). The intervening areas of surficial deposits were mapped by the author largely in a reconnaissance fashion between 1981 and 1983, with the exception of an area east of Lynndyl that was mapped in great detail by Varnes and Van Horn (1984). The physical properties of bedrock and surficial units were not determined for this map, but some soils engineering data are available in public documents, for example, Utah State Department of Highways (1971), Stott (1977), and numerous private site investigations reports prepared for the Intermountain Power Agency and the U.S. Air Force, pertaining to the Intermountain Power Project site and the M-X Missile siting scheme, respectively. The ground-water hydrology and its relation to surficial deposits in a large part of the map area has been described by Holmes (1984).

The quality of geologic source materials used in this map is shown in the reliability diagram (fig. 3), mainly to indicate the state of geologic knowledge in the quadrangle and where future geologic studies might best be directed. The rocks have not changed in historic time but interpretations based on them have, and ongoing improvements in access, mapping and laboratory techniques, and topographic base maps will benefit future interpretations.

Map units selected for use on this map correspond as nearly as possible to a division of geologic periods into epochs. The map-unit boundaries, in most cases, match epoch boundaries, but where a formation boundary straddles a time boundary the formation is arbitrarily included in one or the other adjacent unit, and owing to map scale and thickness of map units, the map pattern is not noticeably different than if the formation had been included in the other adjacent map unit. An attempt at consistency in usage is made, but differences in mapping style and interpretation in the source materials inadvertantly may cause some misidentifications or misassignments. In some cases the map units consist of a single formally recognized formation and in other cases two or more formations.

The igneous rocks are separated into intrusive and extrusive units, and--where not formally named--are informally named to indicate their distribution throughout the quadrangle; the correlations are approximate and based on the available physical evidence and sparse radiometric dates. The igneous units in the Keg, Simpson, and Desert Mountains and in the area around Sage Valley need to be studied in detail before more meaningful relations can be established throughout the quadrangle.

GEOLOGIC SETTING

The geologic setting of the region including the Lynndyl quadrangle is controlled by the regional structure, and the reader is referred to papers by Morris (1983) and Christie-Blick (1983) for a comprehensive description of the regional structure. Paleozoic rocks herein are separated into three "facies" determined by their position relative to two major thrust faults, the Tintic Valley and Sheeprock thrusts (fig. 4). The Tintic Valley thrust is exposed in the east half of the Gilson Mountains and south end of the East Tintic Mountains, and its position under Tintic Valley is dictated by significant facies changes in Cambrian to Devonian rocks between the East and West Tintic ranges. The Sheeprock thrust is exposed in the West Tintic and Sheeprock Mountains and its presence under the Sand Hills, Black Mountains, and Jericho Ridge is indicated by lithologic differences in Lower and Middle Cambrian rocks and proximity of Pennsylvanian rocks. The Canyon Range thrust is considered to be part of the Sheeprock thrust displaced along the Leamington transcurrent fault (Morris, 1983). (The Canyon Range thrust fault and the Canyon Range

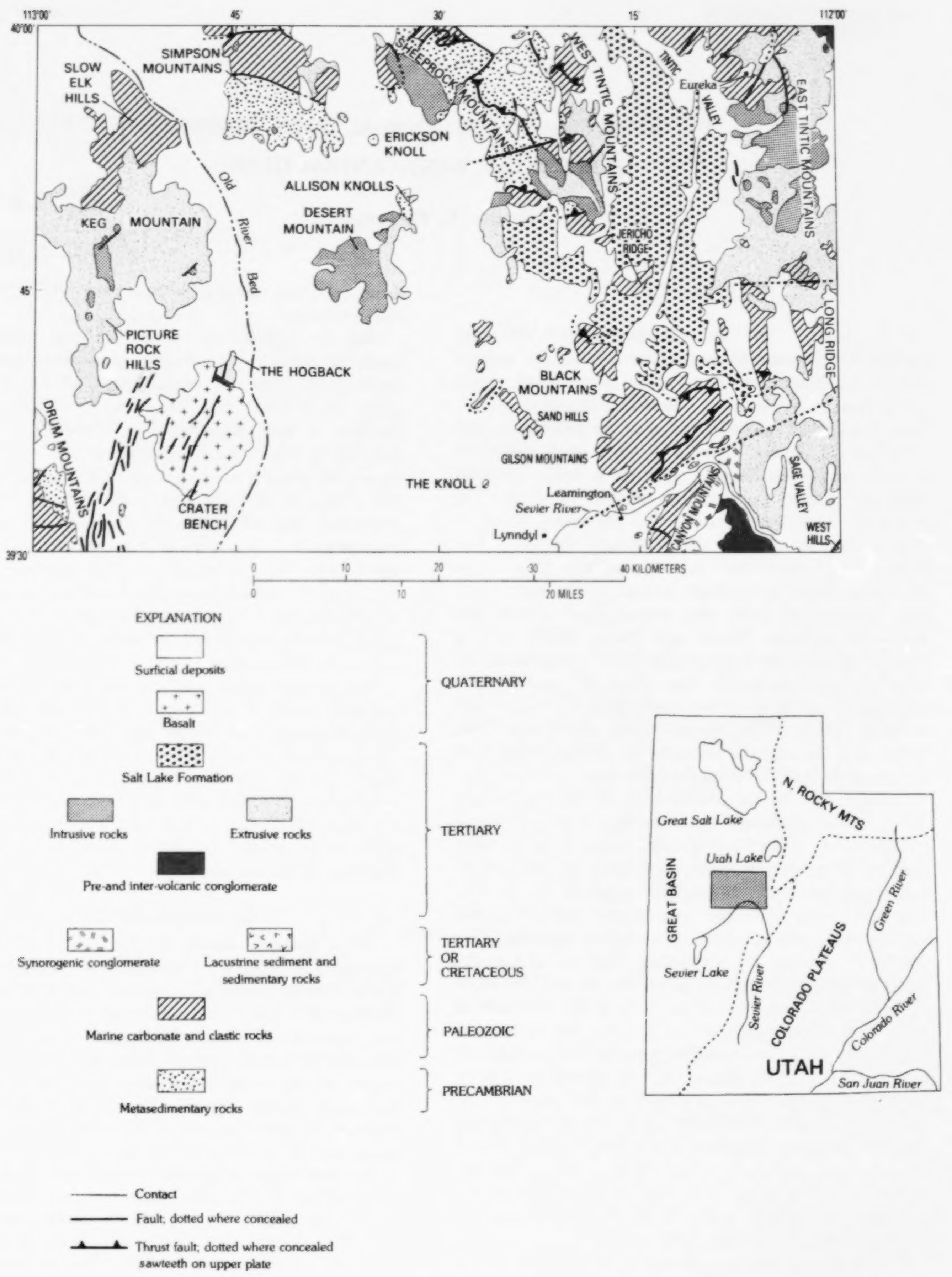
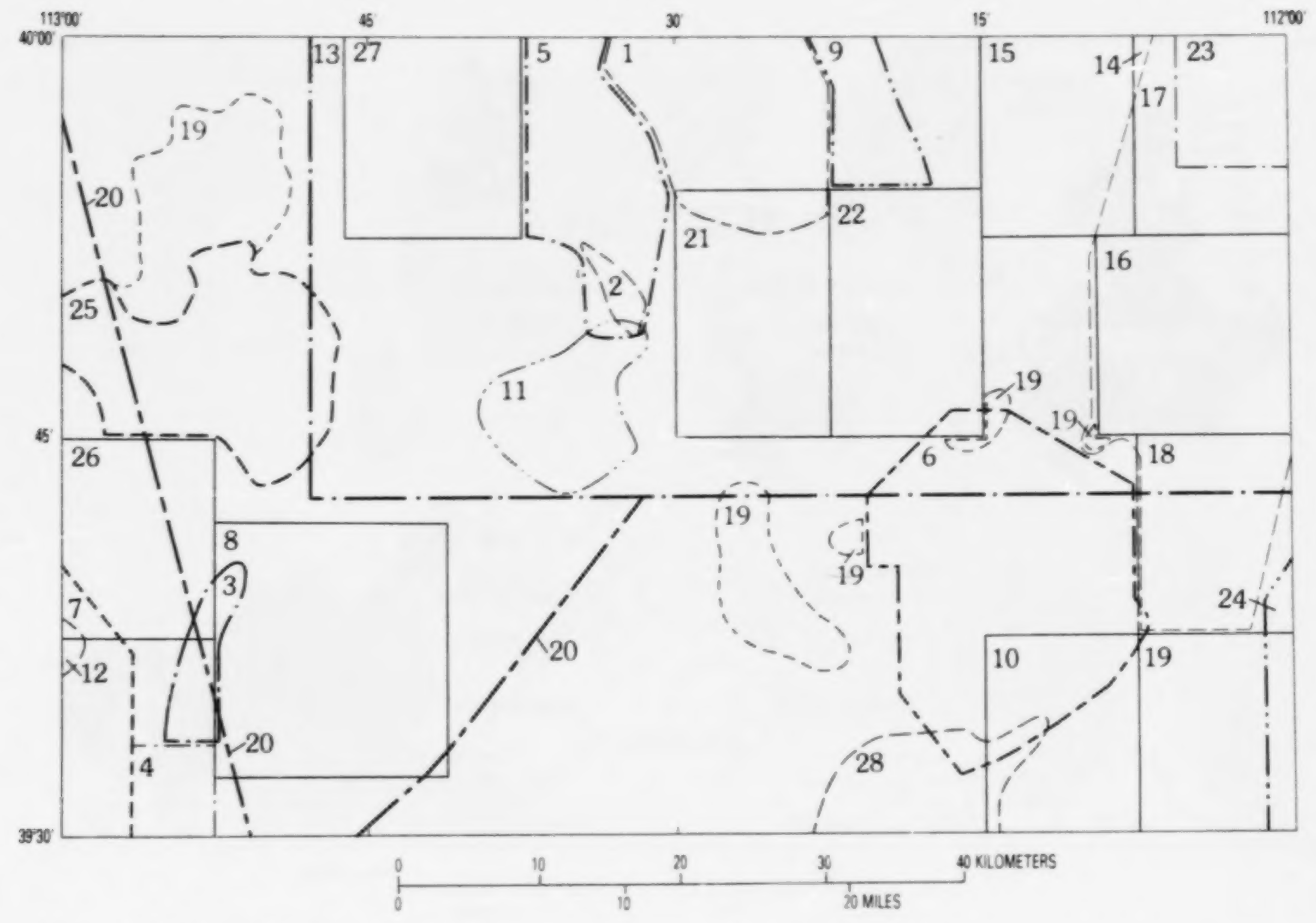


Figure 1.—Generalized geologic map of the Lynndyl 30- by 60-minute quadrangle, and index map of Utah showing location of quadrangle (shaded) and other pertinent features.



1. Blick (1979) and Christie-Blick (1982; 1983)
2. Blick (1979)
3. Faults from Bucknam and Anderson (1979a) and R.C. Bucknam, unpubl. data, 1982, with additions
4. Faults from Bucknam and Anderson (1979a) and Crone (1983), with additions
5. Cohenour (1959), modified by Morris (1978), with additions
6. Costain (1960) and Morris (1978)
7. Dommer (1980), with additions and modifications
8. Galyardt and Rush (1981), with additions and modifications
9. Groff (1959), modified by Morris (1978), with additions
10. Higgins (1982)
11. Kattelman (1968) and Rees and others (1973), modified by Morris (1978)
12. Lindsey (1979)
13. Mabey and Morris (1967) and Morris (1977)
14. Morris (1964a)
15. Morris (1964b)
16. Morris (1975)
17. Morris (1975)
18. Morris (1977)
19. Morris (1978), with additions and modifications
20. Regional structural features from Morris (1983) and H.T Morris, oral commun., 1984
21. Morris and Kopf (1970a), with modifications
22. Morris and Kopf (1970b; 1967), with modifications
23. Morris and Lovering (1979)
24. Muessig (1951a)
25. Shawe (1972) and Lindsey and others (1975), modified by Morris (1978), with additions
26. Staub (1975), modified by Morris (1978), with additions
27. Thomas (1958), modified by Morris (1978; unpubl. data, 1985)
28. Varnes and Van Horn (1984; unpubl. data, 1981)

Figure 2.—Index to geologic mapping, Lynndyl 30- by 60-minute quadrangle, Utah. (Bedrock and locally surficial geology compiled or adapted from these sources.)

Formation of Stolle (1978) have their type areas in the Canyon Mountains, a physiographic unit known in the geologic literature as the Canyon Range.) The Frisco-Wah Wah thrust is not exposed in the Lynndyl quadrangle but its presence is required to explain lithologic differences between lower Paleozoic rocks of the western part of the quadrangle and those just beyond the west edge. The Precambrian to Middle Cambrian rocks of the part of the Drum Mountains in the Lynndyl quadrangle, however, are the same as and included with those of the Sheeprock plate.

The Proterozoic section, most complete in the Sheeprock Mountains where it is more than 6,500 m thick (Christie-Blick, 1982), consists of metasedimentary rocks that include a thick section of tillite. Overlying the Proterozoic rocks along the east edge of the quadrangle is a Paleozoic sedimentary section that exceeds 10,000 m, more than half of which is Pennsylvanian and Permian Oquirrh Formation (Morris, 1964a, 1964b, 1977) (fig. 5). Westward across the quadrangle, upper Paleozoic rocks are not exposed, but lower Paleozoic rocks are represented by about 4,200 m of Cambrian and Ordovician beds (Dommer, 1980), almost twice the thickness of equivalent rocks at the east edge of the quadrangle. The westward increase in thickness of Paleozoic rocks toward the axis of the Cordilleran geosyncline is emphasized by foreshortening across several major thrust faults. Unconformably above the Paleozoic rocks in the southeast corner of the quadrangle is as much as 1,000 m of coarse conglomerate (Higgins, 1982) resulting from thrusting in

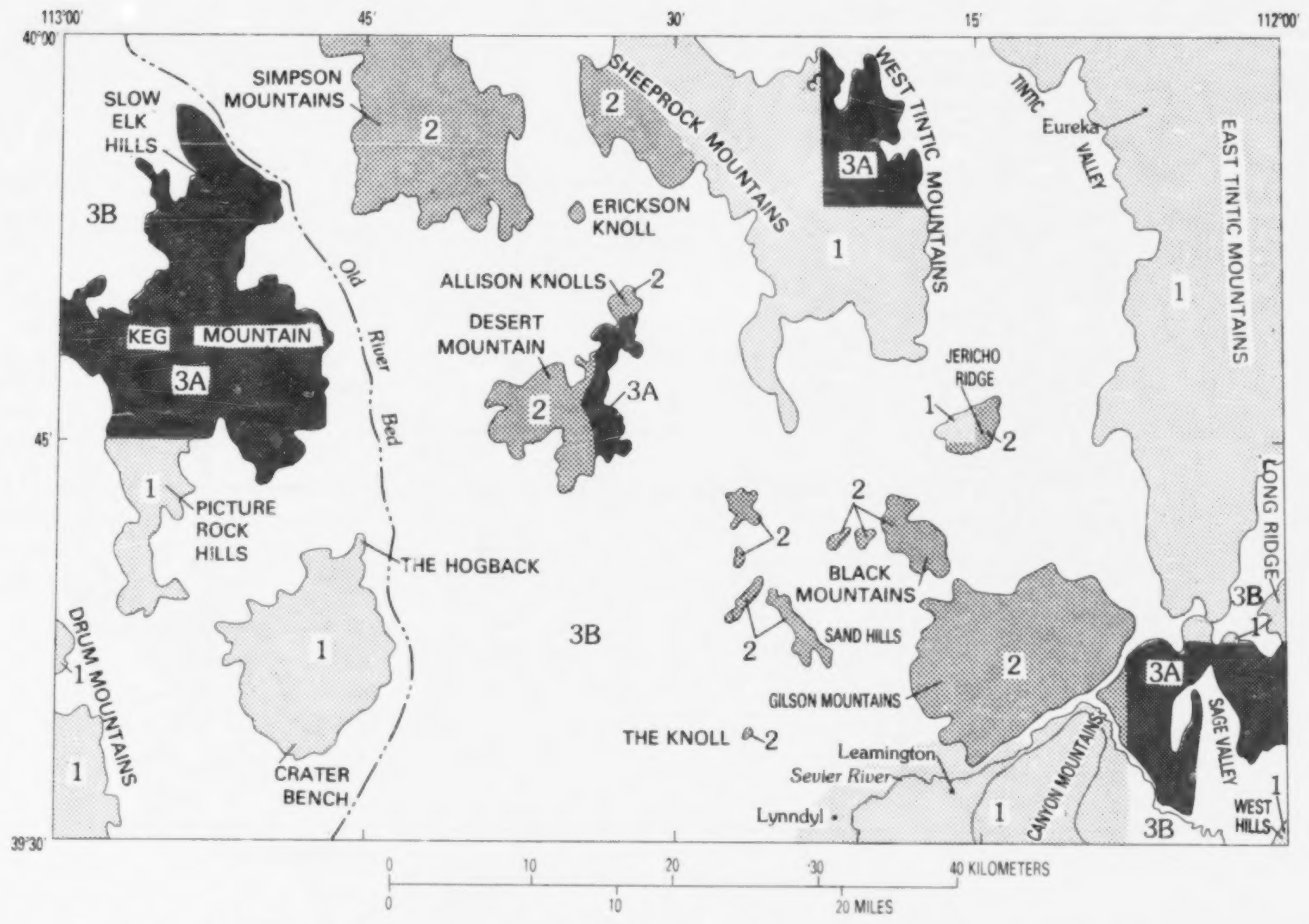


Figure 3.—Geologic data used in this map were compiled from a variety of sources ranging from detailed to rapid reconnaissance field studies plotted on good, large-scale (1:24,000) to poor, small-scale (1:250,000) topographic maps and aerial photographs. This diagram is an assessment of the overall quality of the geologic materials as they pertain to this 1:100,000-scale geologic map.

EXPLANATION

1	Few additions or modifications needed	3A	Many additions or modifications needed
2	Some additions or modifications needed	3B	Many additions and modifications needed in areas of surificial deposits

Late Cretaceous or early Tertiary time. This conglomerate is succeeded by--and in places equivalent to--finer fluviatile conglomerates and lacustrine limestones, the latter being widely exposed east of the quadrangle. Other local deposits of fluviatile conglomerate are present under and interlayered with a succession of Eocene to Miocene extrusive rocks widespread in the quadrangle; intrusive rocks closely related to the extrusive rocks are present in much of the area and in places cut the major faults. This period of igneous activity was followed by regional deposition of a thick sequence of fine-grained lacustrine deposits with volcanic ash interbeds--the Miocene and Pliocene Salt Lake Formation. In Pleistocene time local eruptions of basaltic lava and ash in and south of the quadrangle occurred during the accumulation of Lake Bonneville deposits. Although the major tectonic events preceeded late Cenozoic time, late Pleistocene or Holocene faulting is manifested by a swarm of faults that cut Lake Bonneville deposits in the southwest corner of the area (Bucknam and Anderson, 1979b; Crone, 1983).

In general, igneous rocks of the east half of the quadrangle--and those west of the quadrangle--have been studied in greater detail than those in the west half, mainly because of their relations to ore deposits. Both intrusive and extrusive rocks are predominantly of intermediate composition and consist of monzonite and quartz monzonite stocks and latite and quartz latite flows and tuffs, with some acidic and basic rocks present locally.

Lacustrine deposits of the Salt Lake Formation crop out in the eastern half of the Lynndyl quadrangle above the Bonneville shoreline, from about 1,567m up to about 1,920 m. Below the Bonneville shoreline, which ranges from an elevation of about 1,559 m to 1,593 m across the map area, the Salt Lake deposits either are covered, eroded, or reworked and indistinguishable from fine-grained Lake Bonneville deposits. An isolated exposure of Salt Lake deposits is present at the south edge of Crater Bench in a quarry opened in 1982 to supply ballast for the spur railroad between Lynndyl and the Intermountain Power Project site. There, reddish-brown to pink, fine clastic sediments are unconformably overlain by the Basalt of Crater Bench. These beds, lithologically identical to the Salt Lake deposits north of the Gilson Mountains, appear to be a remnant of the Salt Lake Formation protected from erosion in Lake Bonneville by the basalt cap. Crater Bench is surrounded by wave-worked basalt scree and is capped with patches of fossilferous fine-grained deposits of Lake Bonneville. Three sections of Lake Bonneville

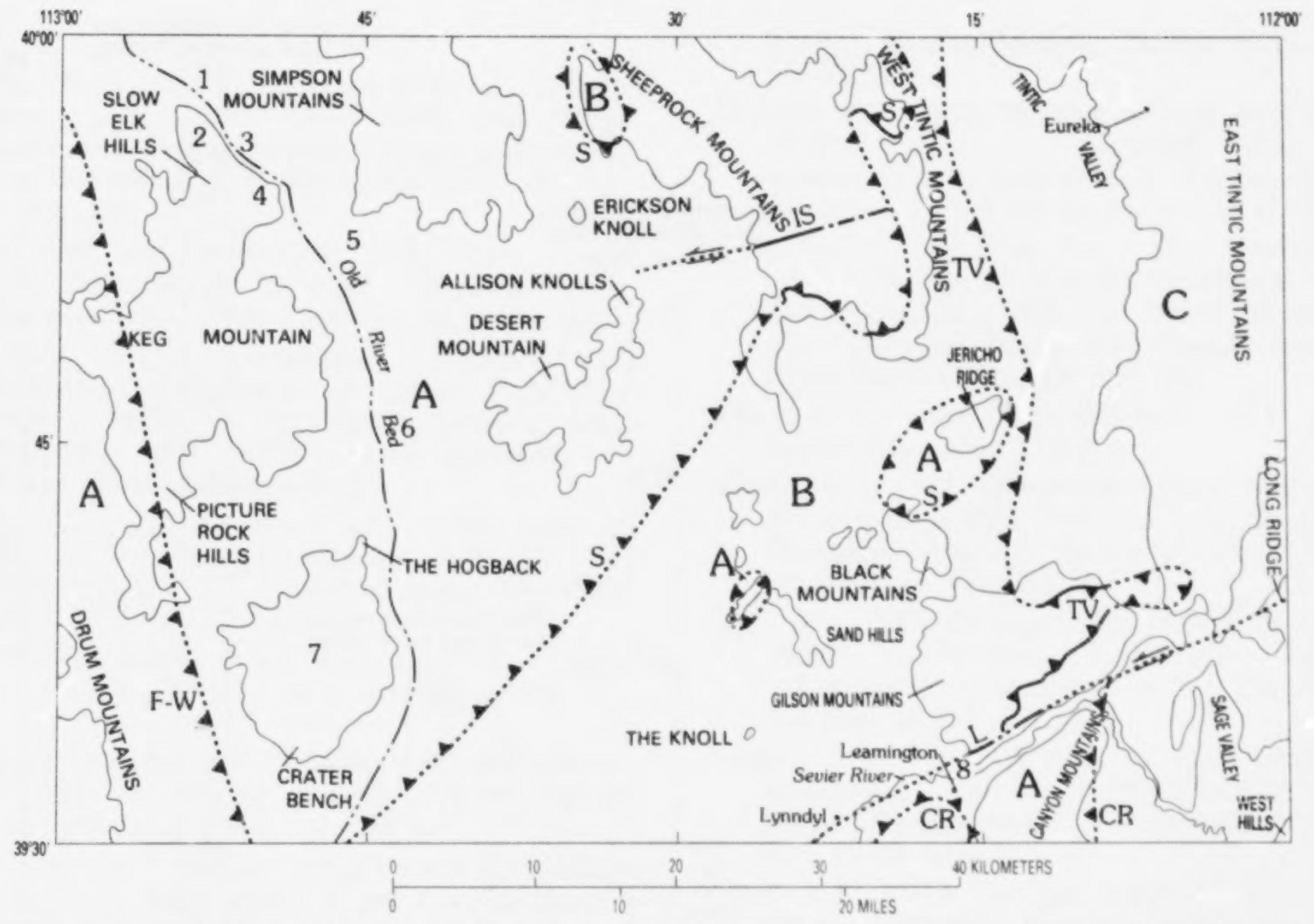


Figure 4. Generalized map showing structural framework of the Lynndyl quadrangle as determined from distribution of pre-Mesozoic sedimentary rocks, after Morris (1983). F-W, Frisco-Wah Wah thrust; IS, Indian Spring transcurrent fault; S, Sheeprock thrust; TV, Tintic Valley thrust; L, Leamington transcurrent fault; CR, Canyon Range (= Sheeprock) thrust. Faults are dotted where inferred; sawteeth are on upper plate of thrust faults; arrows indicate relative movement. The Sheeprock, Tintic Valley, and Leamington faults form the boundaries of three Paleozoic lithologic facies, A, B, and C (see correlation of map units). Also shown are localities of geomorphic features described by Gilbert (1890): 1, Lower River Bed section (p. 189-191); 2, Reservoir Butte (p. 148-149, pls. VII, XXIV, XXV, XXXI); 3, Upper River Bed section (p. 194-196, pl. XXXII); 4, Cup Butte (p. 55, 138, pls. VI, XXIII, XXXI); 5, The Snowplow (p. 138, 147-148, pls. VII, XIX, XXIII, XXXI); 6, Old River Bed (p. 181-184, pl. XXXXI); 7, Fumarole Butte (p. 332-335, pl. XXXI); 8, Leamington section (p. 192-193).

deposits, originally used by Gilbert (1890) to derive his theory of lake-level oscillations, lie within the Lynndyl quadrangle; the Upper and Lower River Bed and Leamington localities (fig. 4). Modern studies by Varnes and Van Horn (1961) and Currey and others (1983) have reinterpreted the history of Lake Bonneville on the basis of these same stratigraphic sections. The quadrangle also contains lacustrine geomorphic features described by Gilbert (1890), for example, Reservoir Butte (Table Mountain on modern maps), Cup Butte, The Snowplow, and the Old River Bed (fig. 4).

Metallic mineral resources of the quadrangle consist chiefly of gold, silver, lead, and zinc with lesser amounts of copper, manganese, and tungsten, and traces of beryllium, thorium, samarian, and uranium. Major base- and precious-metal ore bodies in the East Tintic Mountains have been worked since the early 1870's (Billingsley and Crane, 1933); smaller deposits in the West Tintic, Sheeprock, and Simpson Mountains and at Desert Mountain also have been productive. The base- and precious-metal deposits occur as narrow veins in igneous rocks and as replacement veins and bodies in carbonate rocks, and are thought to represent the culmination of Tertiary igneous activity. Thorium-and samarium-bearing minerals are found in pegmatite dikes cutting granite, and beryl is disseminated in the same granite in the Sheeprock Mountains (Cohenour, 1959). The uranium appears to be localized in fluorite, which occurs in some base-metal veins. For detailed information on the history of mining and the stratigraphic and structural controls and mineralogy of these ore deposits the reader is referred to papers by Lindgren and Loughlin (1919), Butler and others (1920), Billingsley and Crane (1933), Stringham (1942), Cohenour (1959), and Morris (1968). The world's largest beryllium deposits are in the Thomas Range, about 15 km west of the quadrangle, and this range also contains well-known deposits of topaz (Staatz and Carr, 1964.

Nonmetallic resources of the quadrangle are halloysite clay, high-purity limestone, high-silica quartzite, and construction materials. The major United States source of catalytic grade halloysite is just south of Eureka where it occurs in pipelike bodies in lower Paleozoic limestone near the monzonite porphyry contact. Summary statements on the metallic and nonmetallic commodities of this area are found in a report on the mineral resources of Utah (U.S. Geological Survey, 1964).

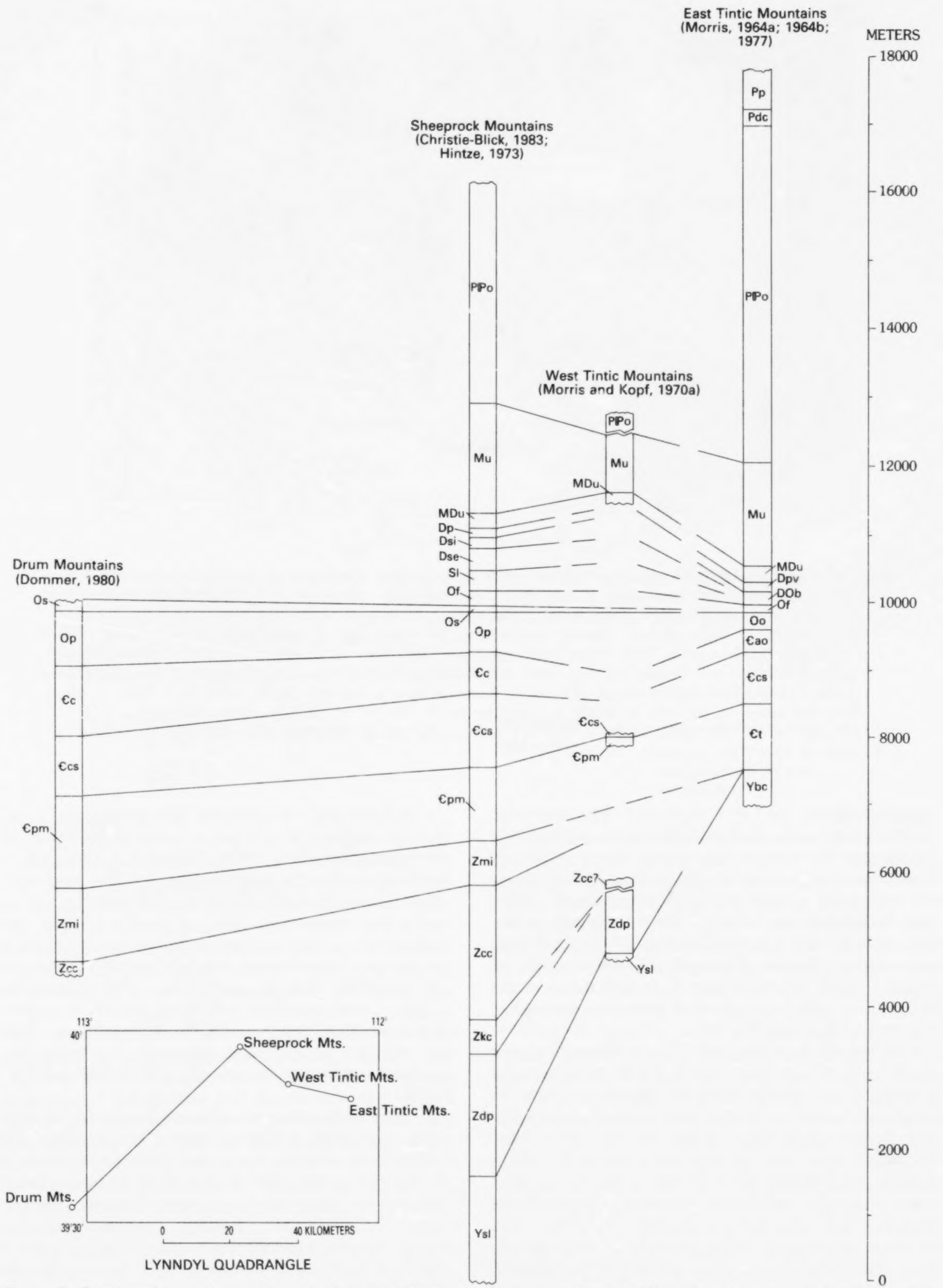


Figure 5. Stratigraphic sections across the Lynndyl 30- by 60-minute quadrangle, Utah. See description of map units for explanation of letter symbols.

REFERENCES CITED

Armstrong, R.L., 1970, Geochronology of Tertiary igneous rocks, eastern Great Basin and Range Province, western Utah, eastern Nevada, and vicinity, U.S.A.: Geochimica et Cosmochimica Acta, v. 34, no. 2, p. 203-232.

Billingsley, Paul, and Crane, G.W., 1933, Tintic mining district: International Geologic Congress, 16th, Washington, D.C., 1933, Guidebook 17, p. 101-124.

Blick, N.H., 1979, Stratigraphic, structural and paleographic interpretation of upper Proterozoic glaciogenic rocks in the Sevier orogenic belt, northwestern Utah (Ph.D. thesis): University of California, Santa Barbara, 633 p.

Bucknam, R.C., and Anderson, R.E., 1979a, Map of scarps on consolidated sediments, Delta 1° x 2° quadrangle, Utah: U.S. Geological Survey Open-File Report 79-366, scale 1:250,000.

______1979b, Estimation of fault-scarp ages from a scarp-height--slope-angle relationship: Geology, v. 7, p. 11-14.

Butler, B.S., Loughlin, G.F., Heikes, V.C., and others, 1920, The ore deposits of Utah: U.S. Geological Survey Professional Paper 111, 672 p.

Campbell, J.A., 1979, Middle to late Cenozoic stratigraphy and structural development of the Canyon Range, central Utah: Utah Geology, v. 6, no. 1, p. 1-16.

Christiansen, F.W., 1952, Structure and stratigraphy of the Canyon Range, central Utah: Geological Society of America Bulletin, v. 63, no. 7, p. 717-740.

Christie-Blick, Nicholas, 1982, Upper Proterozoic and Lower Cambrian rocks of the Sheeprock Mountains, Utah: Regional correlation and significance: Geological Society of America Bulletin, v. 93, no. 8, p. 735-750.

______1983, Structural geology of the southern Sheeprock Mountains: Regional significance: Geological Society of America Memoir 157, p. 101-124.

Cohenour, R.E., 1959, Sheeprock Mountains, Tooele and Juab Counties, Utah: Utah Geological and Mineralogical Survey Bulletin 63, 200 p., pl. 1, scale 1:135,000.

Costain, J.K., 1960, Geology of the Gilson Mountains and vicinity, Juab County, Utah (Ph.D. thesis): University of Utah, Salt Lake City, 139 p., pl. 1, scale 1:40,877.

Crane, G.W., 1917, Geology of the ore deposits of the Tintic mining district, Utah: American Institute of Mining Engineers, Transactions, v. 54, p. 342-355.

Crone, A.J., ed., 1983, Paleoseismicity along the Wasatch fault and adjacent areas, central Utah: Utah Geological and Mineral Survey Special Studies 62, pt. IV (Geologic excursions in neotectonics and engineering geology in Utah), p. 1-45.

Currey, D.R., 1982, Lake Bonneville: selected features of relevance to neotectonic analysis: U.S. Geological Survey Open-File Report 82-1070, scale 1:500,000.

Currey, D.R., Oviatt, C.G., Plyler, G.B., 1983, Lake Bonneville stratigraphy, geomorphology, and isostatic deformation in west-central Utah: Utah Geological and Mineral Survey Special Studies 62, p. 63-82.

Dommer, M.L., 1980, The geology of the Drum Mountains, Millard and Juab Counties, Utah: Brigham Young University Geology Studies, v. 27, pt. 3, p. 55-72, plates.

Erickson, M.P., 1963, Volcanic geology of western Juab County, Utah, *in* Beryllium and uranium mineralization in western Juab County, Utah: Utah Geological Society Guidebook, no. 17, p. 23-35.

Galyardt, G.L., and Rush, F.E., 1981, Geologic map of the Crater Springs Known Geothermal Resources Area and vicinity, Juab and Millard Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Series Map I–1297, scale 1:24,000.

Gilbert, G.K., 1890, Lake Bonneville: U.S. Geological Survey Monograph 1, 448 p.

Goode, H.D., 1961, Quaternary system, *in* Morris, H.T., and Lovering, T.S., Stratigraphy of the East Tintic Mountains, Utah: U.S. Geological Survey Professional Paper 361, p. 129-138.

Groff, S.L., 1959, Geology of the West Tintic Range and vicinity, Tooele and Juab Counties, Utah (Ph.D. thesis): University of Utah, Salt Lake City, 183 p., pl. 1, scale 1:20,439.

Higgins, J.M., 1982, Geology of the Champlin Peak quadrangle, Juab and Millard Counties, Utah: Brigham Young University Geology Studies, v. 29, pt. 2, p. 40-58, scale 1:24,000.

Hintze, L.F., 1973, Geologic history of Utah: Brigham Young University Geology Studies, v. 20, pt. 3, 181 p.

Hogg, N.C., 1972, Shoshonitic lavas in west central Utah: Brigham Young University Geology Studies, v. 19, pt. 2, p. 133-184.

Holmes, W.F., 1984, Ground-water hydrology and projected effects of ground-water withdrawls in the Sevier Desert, Utah: Utah Department of Natural Resources, Technical Publication No. 79, 54 p.

Izett, G.A., and Wilcox, R.E., 1982, Map showing localities and inferred distribution of the Huckleberry Ridge, Mesa Falls, and Lava Creek ash beds (Pearlette Family Ash Beds) of Pliocene and Pleistocene age in the western United States and southern Canada: U.S. Geological Survey Miscellaneous Investigations Series Map I-1325, scale 1:4,000,000.

Kattelman, D.E., 1968, Geology of the Desert Mountain intrusives, Juab County, Utah: Brigham Young University Geology Studies, V. 15, pt. 1, p. 85-107.

Krusi, A.P., and Patterson, R.H., 1980, Problems in Lake Bonneville stratigraphic relationships in the northern Sevier basin revealed by exploratory trenching, *in* Proceedings of Conference X, Earthquake hazards along the Wasatch-Sierra Nevada frontal fault zones: U.S. Geological Survey Open-File Report 80-801, p. 509-518.

Laughlin, A.W., Lovering, T.S., and Mauger, R.L., 1969, Age of some Tertiary igneous rocks from the East Tintic district, Utah: Economic Geology, v. 64, no. 8, p. 915-918.

Lindgren, Waldemar, and Loughlin, G.F., 1919, Geology and ore deposits of the Tintic mining district, Utah: U.S. Geological Survey Professional Paper 107, 282 p.

Lindsey, D.A., 1979, Geologic map and cross-sections of Tertiary rocks in the Thomas Range and northern Drum Mountains, Juab County, Utah: U.S.

Geological Survey Miscellaneous Investigation Series Map I-1176, scale 1:62,500.

______1982, Tertiary volcanic rocks and uranium in the Thomas Range and northern Drum Mountains, Juab County, Utah: U.S. Geological Survey Professional Paper 1221, 71 p.

Lindsey, D.A., Naeser, C.W., and Shawe, D.R., 1975, Age of volcanism, intrusion, and mineralization in the Thomas Range, Keg Mountain, and Desert Mountain, western Utah: U.S. Geological Survey Journal of Research, v. 3, no. 5, p. 597-604.

Mabey, D.R., and Morris, H.T., 1967, Geologic interpretation of gravity and aeromagnetic maps of Tintic Valley and adjacent areas, Tooele and Juab Counties, Utah: U.S. Geological Survey Professional Paper 516-D, 10 p., 1 pl., scale 1:125,000.

Mehnert, H.H., Rowley, P.D., and Lipman, P.W., 1978, K-Ar ages and geothermal implications of young rhyolites in west-central Utah: Isochron West, no. 21, p. 3-7.

Morris, H.T., 1964a, Geology of the Eureka quadrangle, Utah and Juab Counties, Utah: U.S. Geological Survey Bulletin 1142-K, p. K1-K29, scale 1:24,000.

______1964b, Geology of the Tintic Junction quadrangle, Tooele, Juab, and Utah Counties, Utah: U.S. Geological Survey Bulletin 1142-L, p. L1-L23, scale 1:24,000.

______1968, The main Tintic mining district, Utah, *in* Ridge, J.D., ed., Ore deposits of the United States, 1933-1967 (Graton-Sales Volume), pt. 2: New York, American Institute of Mining, Metallurgical, and Petroleum Engineers, p. 1043-1073.

______1975, Geologic map and sections of the Tintic Mountain quadrangle and adjacent part of the McIntyre quadrangle, Juab and Utah Counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-883, scale 1:24,000.

______1977, Geologic map and sections of the Furner Ridge quadrangle, Juab County, Utah: U.S. Geological Survey Miscellaneous Investigations Map I-1045, scale 1:24,000.

______1978, Preliminary geologic map of Delta 2° quadrangle, west-central Utah: U.S. Geological Survey Open-File Report 78-705, scale 1:250,000.

______1983, Interrelations of thrust and transcurrent faults in the central Sevier orogenic belt near Leamington, Utah: Geological Society of America Memoir 157, p. 75-81.

Morris, H.T., and Kopf. R.W., 1967, Breccia pipes in the West Tintic and Sheeprock Mountains, Utah *in* Geological Survey Research 1967: U.S. Geological Survey Professional Paper 575-C, p. C66-71.

______1970a, Preliminary geologic map and cross sections of the Cherry Creek quadrangle and adjacent part of the Dutch Peak quadrangle, Juab County, Utah: U.S. Geological Survey Open-File Map 70-233, scale 1:24,000.

______1970b, Preliminary geologic map and cross section of the Maple Peak quadrangle and adjacent part of the Sabie Mountain quadrangle, Juab County, Utah: U.S. Geological Survey Open-File Map 70-234, scale 1:24,000.

Morris, H.T. and Lovering, T.S., 1961, Stratigraphy of the East Tintic Mountains, Utah, *with a section on* Quaternary deposits by H.D. Goode: U.S. Geological Survey Professional Paper 361, 145 p.

______1979, General geology and mines of the East Tintic mining district, Utah and Juab Counties, Utah: U.S. Geological Survey Professional Paper 1024, 203 p.

Morris, H.T., Douglass, R.C., and Kopf, R.W., 1977, Stratigraphy and microfaunas of the Oquirrh Group in the southern East Tintic Mountains, Utah: U.S. Geological Survey Professional Paper 1025, 22 p.

Muessig, S.J., 1951a, Geology of a part of Long Ridge, Utah (Ph.D. thesis): Ohio State University, Columbus, 213 p.

______1951b, Eocene volcanism in central Utah: Science, v. 114, p. 234.

Peterson, J.B., and Nash, W.P., 1980, Geology and petrology of the Fumarole Butte volcanic complex, Utah, *in* Studies in late Cenozoic volcanism in west-central Utah: Utah Geological and Mineral Survey Special Studies 52, pt. II, p. 34-58.

Rees, D.C., Erickson, M.P., and Whelan, J.A., 1973, Geology and diatremes of Desert Mountain, Utah: Utah Geological and Mineralogical Survey Special Studies 42, 12 p., scale 1:24,000.

Shawe, D.R., 1972, Reconnaissance geology and mineral potential of the Thomas, Keg, and Desert Calderas, central Juab County, Utah, *in* Geological Survey Research 1972: U.S. Geological Survey Professional Paper 800-B, p. B67-B77.

Staatz, M.H., and Carr, W.J., 1964, Geology and mineral deposits of the Thomas and Dugway Ranges, Juab and Tooele Counties, Utah: U.S. Geological Survey Professional Paper 415, 188 p.

Staub, A.M., 1975, Geology of the Picture Rock Hills quadrangle, southwestern Keg Mountain, Juab County, Utah (M.S. thesis): University of Utah, Salt Lake City, 87 p.

Stolle, J.M., 1978, Stratigraphy of the Lower Tertiary and Upper Cretaceous(?) continental strata in the Canyon Range, Juab County, Utah: Brigham Young University Geology Studies, v. 25, pt. 3, 117-139.

Stott, L.H., 1977, Soil Survey of Delta area Utah, part of Millard County: U.S. Department of Agriculture, Soil Conservation Service, 77 p.

Stringham, B.F., 1942, Mineralization in the West Tintic mining district, Utah: Geological Society of America Bulletin, v. 53, no. 2, p. 267-290

Thomas, G.H., 1958, Geology of the Indian Springs quadrangle, Tooele and Juab Counties, Utah: Brigham Young University Research Studies, Geology Series, v. 5, no. 4, 35 p., scale 1:27,800.

Tower, G.W., and Smith, G.O., 1899, Geology and mining industry of the Tintic district, Utah: U.S. Geological Survey 19th Annual Report (1897-98), pt. 3, p. 601-676.

U.S. Geological Survey, 1964, Mineral and water resources of Utah: Prepared at the request of Senator Frank E. Moss by the U.S. Geological Survey in cooperation with the Utah Geological and Mineralogical Survey and Utah Water and Power Board, U.S. Government Printing Office, Washington, D.C., 275 p.

Utah State Department of Highways, 1971, Materials inventory, Millard County: Utah State Dept. Highways, Materials & Research Div., Materials Inventory Section, 24 p.

Varnes, D.J., and Van Horn, Richard, 1961, A reinterpretation of two of G.K. Gilbert's Lake Bonneville sections, Utah, *in* Geological Survey Research 1961: U.S. Geological Survey Professional Paper 424–C, p. C–98–C99

______1984, Surficial geologic map of the Oak City area, Millard County, Utah: U.S. Geological Survey Open-File Report 84-115, scale 1:31,680.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1989-0-234-086